DETAILED PROJECT REPORT

VOLUME II - MAIN REPORT
(PART D)

SEMI HIGH SPEED RAIL CORRIDOR
THIRUVANANTHAPURAM TO KASARAGOD

KERALA RAIL DEVELOPMENT CORPORATION LTD

DETAILED PROJECT REPORT

VOLUME II - MAIN REPORT

(PART D)

SEMI HIGH SPEED RAIL CORRIDOR
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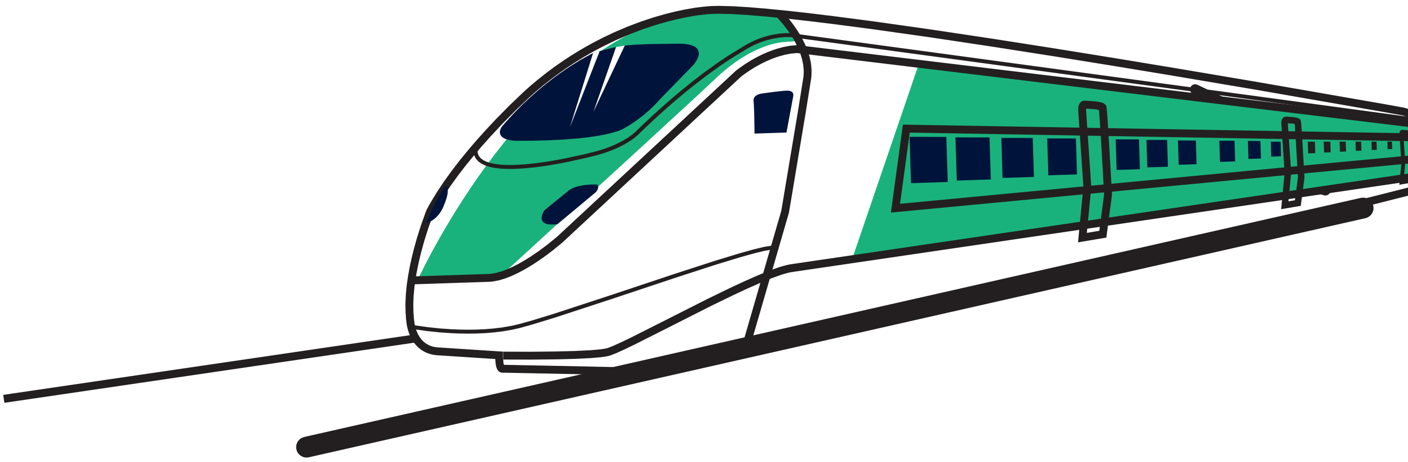

K-rail

SYSTRA

DETAILED PROJECT REPORT – (VOLUME II: PART D)

DETAILED PROJECT REPORT FOR SILVERLINE (SEMI HIGH SPEED RAIL) FROM THIRUVANANTHAPURAM TO KASARAGOD

IDENTIFICATION TABLE	
Client/Project owner	Kerala Rail Development Corporation Limited (K-RAIL)
Project	SilverLine (Semi High Speed Rail) From Thiruvananthapuram To Kasaragod
Study	Detailed Project Report For SilverLine (Semi High Speed Rail) From Thiruvananthapuram To Kasaragod
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VOLUME II - MAIN REPORT
(PART D)

CHAPTER 15
DETAILED PROJECT COST ESTIMATE

15 DETAILED PROJECT COST ESTIMATE

15.1 INTRODUCTION

Detailed Capital Cost estimate for the proposed SilverLine high speed rail corridor from Thiruvananthapuram to Kasaragod has been prepared covering all the major heads of the cost as mentioned below at March 2020 price levels;

(i) Land acquisition and R&R
(ii) Alignment, formation and bridges
(iii) Station buildings
(iv) Permanent way
(v) E & M works
(vi) Depot and workshop
(vii) Power Supply and Traction
(viii) Signalling & Train Control and Communication
(ix) Ticketing and Fare collection
(x) Rolling stock
(xi) Miscellaneous works
(xii) PMC and design Charges
(xiii) Contingencies
(xiv) Taxes

Capital cost estimate have been prepared for the Civil and System works of SilverLine corridor. The cost has been calculated as per route km for items spread over the alignment and per unit for other items. All items related to the alignment, whether at grade, underground or elevated construction, permanent way, OHE, Signalling & Train Control and Communication, have been estimated on cost per km basis. The cost of stations is estimated separately on area basis from similar works of Metro and Railway stations and depots are estimated separately as per the initial/conceptual plans developed.

Cost of E&M works, Permanent way, Power supply, Signalling & Train Control and Communication, Ticketing & Fare collection, rolling stock, have been assessed separately.

Land cost has been assessed based on each segment of the land that is required.

15.2 CAPITAL COST

The project cost for Semi high speed rail corridor between Thiruvananthapuram to Kasaragod at March 2020 Price levels is given in table below.

Table 15-1: Capital Cost Estimate – Abstract (INR in Crores)

Sl.No	ITEM	AMOUNT IN Cr
1	Land*	
1.1	Private land	6100.30
1.2	Government land	0.00
1.3	Railway land	975.00
1.4	Cost for compensation of structure	4460.00
	Sub total	11535.30
1.5	Cost of R&R	1730.00
	Sub total (1)	**13265.30**
2	Alignment and Formation	
2.1	Tunnel (including ventilation & lighting)	1325.72
2.2	Cut & Cover	1215.83
2.3	Viaduct	3501.12
2.4	Embankment	3031.63
2.5	Cutting	711.32
	Sub total (2)	**9785.62**
2.6	Bridges	663.84
	Sub Total (3)	**663.84**
2.7	ROBs & RUBs	
2.7.1	ROBs with Piles	1778.00
2.7.2	ROBs with RE wall as RC box	394.80
2.7.3	ROB in cutting	1030.40
2.7.4	RUB	788.00
2.7.5	Subways	383.00
2.7.6	ROB Modification with additional ventway for Silver line(39 Nos)	51.09

Sl.No	ITEM	AMOUNT IN Cr
	Sub total (4)	**4425.29**
2.8	Civil Miscellaneous	
2.8.1	RORO - including parking for 40 trucks and ramp and ancillary facilities	675.00
2.8.2	Compound wall, RCC wall handrail 1m high, Fencing, Inspection PF& ladder for River bridge, Viaduct & River Bridge -special hand rail-walkway, Concertina coil, Signal & Power duct, or drain water pipe & Catch water drain, name boards indication boards etc.	1545.28
	Sub total (5)	**2220.28**
3	Stations	
3.1	Type A Station at ground (incl lifts and escalators, approx parking area etc.) – Kollam, Kannur, Kasaragod	212.00
3.2	Type A Station elevated (incl lifts and escalators, approx parking area etc.) – Kochuveli, Ernakulam, Trissur	280.00
3.3	Type A Station underground (incl lifts and escalators) - Kozhikode	200.00
3.4	Type B Station at ground (incl lifts and escalators) – Tirur, Chenganoor, Kottayam	106.00
3.5	Type B Station elevated (incl lifts and escalators) – NIL	0.00
3.6	Airport Station at Nedumbassery	25.00
3.7	OCC and Administrative Building	100.00
3.8	ASS and Electrical Works	50.00
	Sub total (6)	**973.00**
4	All Depots & miscellaneous	
4.1	Depot at Kollam including work shop and siding track and other infra, MEP and ASS	200.00
4.2	Depot at Kasaragod including work shop, system and siding track and other infra, MEP and ASS	200.00

Sl.No	ITEM	AMOUNT IN Cr
4.3	Machinery at Depot	170.00
4.4	Track recording car, USFD rail testing car, Rail grinding machine, Cantenary installation car etc	125.00
4.5	Accident relief Train and other equipments	175.00
4.6	Track machines & track maintenance including sidings	200.00
4.7	Safety & rescue and relief in tunnels and viaducts, including tunnel ventilation	135.00
4.8	Automatic River water level monitoring system, rain fall monitoring system and wind speed monitoring system	25.00
4.9	Small track machine and satellite depots	50.00
4.10	Continuous Track monitoring by Fibre technology	20.00
	Sub total (7)	**1300.00**
5	Permanent way	
5.1	Ballasted track for embankments, viaduct and yards, loop lines	2992.40
5.2	Ballast less track	552.00
5.3	Points & crossings, special layouts , RORO etc	150.00
	Sub total (8)	**3694.40**
6	Traction and power supply incl. OHE, ASS etc	
6.1	Elevated Section/ At Grade Section	1834.00
6.2	Extra for Underground Section – Tunnel and Cut & Cover	16.00
6.3	OHE – (Two Depot and Sidings)	60.00
6.4	Traction Substations	480.00
	Sub total (9)	**2390.00**
7	Signalling & Train Control, Communication and Ticketing & Fare Collection System	

Sl.No	ITEM	AMOUNT IN Cr
7.1	Signalling & Train Control (ETCS Level-2 with LTE) and Communication System - including depot & sidings	2142.66
7.2	On Board Equipment	38.88
7.3	Ticketing & Fare collection	88.00
7.4	Misc. Ticketing & Fare Collection equipment	5.50
7.5	OCC and BCC (Signalling & Train Control, Communication and Ticketing System arrangement)	150.00
7.6	Signalling & Train Control and Communication Safety System	100.00
	Sub total (10)	**2525.04**
8	Rolling Stock	
8.1	Rolling stock (SG) - Passenger	4176.00
8.2	Rolling Stock - RORO	480.00
	Sub total (11)	**4656.00**
9	Staff quarters and Barracks	
9.1	Staff quarters for O&M	50.00
9.2	Barracks, training centre, camp office..etc	50.00
	Sub total (12)	**100.00**
10	Others	
10.1	Shifting of Utilities	0.00
10.1.1	Shifting of powerlines	240.00
10.1.2	Shifting of pipelines (KWA, Telecom..) (60 Cr for telecom)	70.00
10.1.3	Shifting of minor structures	23.50
10.1.4	Shifting of Rly utilities (depost works to S.Rly)	260.00
10.2	Multi modal Integration (e-bus etc., for last mile connectivity)	95.00
10.3	Security	80.00
10.4	Noise & vibration reduction - Protection & treatment	50.00

Sl.No	ITEM	AMOUNT IN Cr
	Sub total (13)	**818.50**
11	Training Equipment & Machine in training centre including Overseas training	75.00
	Sub total (14)	**75.00**
	Total for all items except land	**33626.97**
12	Land (including JDA and R&R)	13265.30
	TOTAL CAPITAL COST (Excluding Taxes)	**46892.27**
13	Design Charges	672.54
14	PMC Charges	1345.08
15	Contingency Charges	1008.81
	Total Cost excluding Taxes – March 2020 prices	**49918.70**
16	Central Taxes	2688.81
17	State Taxes	2446.33
	Total Project Cost at March 2020 prices	**55053.83**
18	Price Escalation	8722.76
	Project Completion Cost excluding IDC	**63776.59**
19	IDC	164,08
	Project Completion Cost including IDC (all inclusive)	**63940.67**

***** *: Part of Land required for service road is partly saved by constructing suitable RC retainers.*

The details of the cost estimates are discussed in detail in the following paragraphs.

15.2.1 Basis of Capital Cost Estimation

The capital cost of various items has been assessed based on the following principles;

(i) The works like Embankments, Cut and cover, Cutting, Viaduct, Tunnels, Rolling Stock, Power Supply, Signalling & Train Control , Communication, Ticketing & Fare collection, Depots, Machinery and plant (M&P) etc., have been prepared based on consultant’s experience taking the reference of cost of similar items to work out the item rates.

(ii) The rates of different items have been assessed as per rates of USSOR 2011 with 5% escalation, DSR 2018 with 5% escalation, current market prices or rates from similar works in Indian railways and metro projects in India.

(iii) For costs of stations, Lump sum cost has been considered based on likely plinth area of the stations.

(iv) Escalation factor @ 5% per annum has been applied to these estimated costs from other Metro and rail projects to current price level wherever required.

(v) Cost of M&P has been taken from Indian Railways’ COFMOW purchase rates and wherever not available, the rates are taken from other Indian Railway projects or Metro Projects.

(vi) Design cost of 2% and PMC costs of 4% have been estimated on the Cost of construction (Excluding land & R&R) and included in the project cost. Provision for Contingencies have similarly been kept at 3% of the Cost of construction (Excluding land & R&R)

(vii) The taxes and duties in respect of imported materials consist of Custom Duty (CD), Customs Cess and Integrated Goods and Services tax (IGST). The Silverline Project shall be eligible for availing concessional project import duty under chapter 98.01 of the Custom Tariff Act. The Goods and Services tax (GST) rate applicable on works contract, GST rate applicable for rolling stock and GST rate applicable for services of consulting engineers and other services has been considered. Based on these assumptions the detailed project cost estimate has been calculated.

15.2.2 Cost for Civil Engineering Works

Head-wise details of above mentioned items constituting the cost are discussed hereunder.

15.2.2.1 Methodology adopted

Based on the individual quality of various heights/embankment in steps of 0.5 m (2.0m, 2.5m, 3.0m, 3.5m, 4.0m..) and multiplying the same by the unit cost calculated for 3 categories (namely strong ground, weak ground with stone column & weak ground with stone column using geogrid wrap) and the total cost of the embankment is arrived.

Similarly for cutting, an increment of 1m (2.0m, 3.0m, 4m) has been used to multiply the corresponding length of cutting to arrive at the total cost.

Data for embankment, cutting, etc. have been formulated in Excel sheets each for 50 Km stretch of alignment, in order to arrive at

i. Stretches of embankment having height from 2.0m to 8.0m (interval of 0.5m)
ii. Stretches of cutting from 2m to 9m (interval of 1m)
iii. Length of viaduct in the height of 8m ,10m,15m&20m.
iv. Length of cut & cover up to 20m depth (Strong ground & weak ground)
v. Length of tunnels
vi. Right Of Way (ROW) under each height /depth of embankment /cutting category.
vii. Total length of cutting, tunnels viaduct etc.
viii. Total length of embankment
ix. Quantity of E- Work in bank cutting etc…
x. Area of land over the 50 km separately for making formation, making the cuttings, viaduct etc., to arrive at the assessment of cost of land.

Working sheets made in MS Excel are kept at Volume VII (Volume for Working sheet) of this DPR.

15.2.2.2 Land Price

In view of high value of land in Kerala to construct the SilverLine alignment, stations, Depots and power substations, the land requirement has been kept to the bare minimum. Acquisition of Private land has been minimized as far as possible. Even the alignment of the project has been selected in such a way that, it passes through less costly and low inhabited areas so that the cost of the projects can be minimized. Elevated alignment is proposed to be located on the central verge of the road wherever possible. Where this is not possible, minimum land width of 15m is proposed for acquisition.

Table 15-2: Land assessment consideration

Stretches proposed with Structure	Minimum land width considered for acquisition (m)				
	Main structure/Formation	Available road	Median	Extra clearance	Total width with side slopes and compound walls
Viaducts					
Viaducts (single pier)	11	6.1+6.1	2.8	2+2	15

Stretches proposed with Structure	Minimum land width considered for acquisition (m)				
	Main structure/Formation	Available road	Median	Extra clearance	Total width with side slopes and compound walls
Viaducts (Double pier)	11	4.75+4.75	5.5	2+2	15
Embankments					
Up to 2 m	12	NA	NA	NA	20
2-6 m	12	NA	NA	NA	20
Cuttings					
Up to 3m (RC wall)	13.35	NA	NA	NA	25
3-8 m (RC wall)	13.35	NA	NA	NA	25
3-9 (Gabion wall with RE-geogrid + pitching on slope)	13.35	NA	NA	NA	25
Cut and Cover					
Cut and Cover (Near tunnels)	13.5	NA	NA	NA	20
Cut and Cover (Near Cuttings)	14.85	NA	NA	NA	20
Tunnels					
Tunnels	NA	NA	NA	NA	No acquisition Considered

Apart from the above, single lane service road of 3.75m wide wherever required will be accommodated by constructing pre-cast RC wall retainers.

15.2.2.2.1 Procedure Followed in Arriving Cost of Land

The land proposed to be acquired along the corridor is categorised into seven (7) different groups as under to arrive at the cost of land involved.

1) Wet land with road access
2) Wet land without road access
3) Dry land with small road access
4) Dry land without small road access
5) Land with medium type road access
6) Land with SH, NH access
7) Commercially important location

For the station land located in either corporation or municipal limits, market value of land in the vicinity collected from various sources is multiplied by the area to arrive at the cost.

For the mid-section land falling in the stretches between adjoining stations based on width of R.O.W, area under the 7 groups are calculated from the orthophotos obtained during the Ariel LIDAR Survey. Based on reasonable market value of land estimated based on available registered land cost in the local offices, the corresponding areas are multiplied to arrive at the subtotal of the cost of land.

15.2.2.2.2 Average Land Cost

Average Cost of Comm plot	=	(0.84+11.71+5.06+34.44) / 4
	=	Rs.13.01 Cr/Ha.
Average cost of Residential Plot	=	(3.63+1.90+2.62+3.07+6.15+13.27) /6
	=	Rs.5.11 Cr /Ha
Average cost of garden land	=	(1.39+1.76+0.84+1.12+2.58+1.76) /6
	=	1.575 Cr/Ha
Average Cost of wet land	=	0.64+0.79+0.48+0.26+1.11+3.02
	=	Rs.1.05 Cr/Ha
Overall average cost	=	21.075 / 4
	=	**5.26875 Cr/Ha**

15.2.2.3 Compensation Cost towards affected Buildings & Structures

Based on the number of buildings assessed on the alignment, it is seen that about 25% falls under rural area (other than corporation and municipalities). Out of the identified 10349 buildings & structures, approximately 10% are proposed to be retained by constructing protective walls/retaining walls etc., and compensation is worked out as detailed below:-

Affected Structures

Affected structures are estimated as 10349 (out of this save 10% by constructing R/wall) constituted of the following:-

(i) Tiled Building : 3930 Nos
(ii) Single Storeyed : 5949
(iii) Multi-Storeyed : 470 (i) + (ii) = 6419

Total = 10349 = 90 % X 10349 = 9314 structures

From the above, 3930 buildings are located at rural area and 6419 buildings/structures (single and multi-storeyed) in urban area.

Compensation for buildings

Parameters	Rural	Urban
Average area of buildings (To dismantle) Compensation cost For each building Total number of buildings & Structures Factor = 1 and 2 (75 % of structures in Urban)	= 1000 sqft = ($100m^2$) = Rs.1000/Sqft = 10 Lakh (Average) = 9314 Nos (25 % in Rural)	1500 sqft Rs.1500/Sqft 22.5

Compensation Amount

Rural 3930 X 10 lakhs (tiled building) X Factor 2 = Rs. 786 Cr

100% Solatium = Rs. 786 Cr

Urban 6419 X 22.5 lakh X Factor1 = Rs. 1444 Cr

100% Solatium = Rs. 1444 Cr

Total amount of compensation = Rs. 4460 Cr

From the above mentioned compensation amount, 10% further can be saved by constructing retaining walls as stated earlier.

15.2.2.4 Viaduct in-lieu of Cultivable Paddy Fields

At Km. 52.9 to 55.0, 91.8 to 94.6Km., 240 to 245Km., and 295 to 298 Km., as a green initiative, paddy fields under cultivation over 12.3 Km in length are saved by constructing low height viaducts.

15.2.2.5 Basis for Cost Estimation

Cost estimates have been prepared covering civil, electrical, signalling & train control and communications, ticketing & fare collection, rolling stock, etc. at March, 2020 price level and escalated @5% PA.

The overall Project Completion Cost (excluding IDC) for SilverLine corridor between Thiruvananthapuram and Kasaragod at 2020 price levels is given in the Table below.

Table 15-3: Capital cost summary of SilverLine Corridor (in INR Cr.)

Corridor Name	Capital cost	Taxes & Duties	Total (@2020 price levels)	Escalated Completion Cost	Escalated completion cost with IDC
Thiruvananthapuram and Kasaragod	49918	5135	55053	63777	63941

The basis of the rates is also mentioned briefly against each item. The overall capital cost excluding taxes and duties at 2020 price is as given as below.

15.2.2.6 Capital Cost Estimate: SilverLine between Thiruvananthapuram and Kasaragod

The overall project capital cost (except land) excluding taxes and duties for SilverLine between Thiruvananthapuram and Kasaragod at March 2020 price is as given as below.

Table 15-4: Summary of Capital Cost Estimate (in INR Cr.)

Sl. No	Item	Unit	Rate as per March 2020 (in Cr)	Quantity	Amount (in INR Cr)
1	**Alignment and Formation**				
1.1	**Cut and cover**				
1.1.1	Upto 20m depth normal/weak ground	R. Km	33.30	4.43	147.56
1.1.2	Upto 20 depth strong ground	R. Km	28.50	10.60	302.00
1.1.3	**NATM method**	R. Km	78.50	9.76	766.28
				Sub Total	**1215.83**
1.2	**Viaduct**				
1.2.1	8 m high viaduct	R. Km	33.50	20.15	675.04
1.2.2	10 m high viaduct	R. Km	38.80	14.06	545.47
1.2.3	15 m high viaduct	R. Km	39.30	40.14	1577.69
1.2.4	20 m high viaduct	R. Km	50.00	14.06	702.92
				Sub Total	**3501.12**
1.3	**Embankment**				
1.3.1	On strong ground (2 m high)	R. Km	3.80	47.32	179.80
1.3.2	On weak ground (2 m high) stone column	R. Km	7.20	11.72	84.35
1.3.3	On very weak ground (2 m high) stone column using Geo-grid wrap	R. Km	8.10	0.00	0.00
1.3.4	On strong ground (2.5 m high box)	R. Km	5.40	25.38	137.07
1.3.5	On weak ground (2.5 m high box) stone column	R. Km	8.90	5.06	44.99
1.3.6	On very weak ground (2.5 m high box) stone column using Geo-grid wrap	R. Km	9.80	0.00	0.00
1.3.7	On strong ground (3 m high)	R. Km	6.80	27.07	184.05
1.3.8	On weak ground (3 m high) stone column	R. Km	10.20	7.17	73.16

Sl. No	Item	Unit	Rate as per March 2020 (in Cr)	Quantity	Amount (in INR Cr)
1.3.9	On very weak ground (3 m high) stone column using Geo-grid wrap	R. Km	11.20	0.00	0.00
1.3.10	On strong Ground (3.5 m high)	R. Km	8.20	34.63	283.93
1.3.11	On weak Ground (3.5m high) stone column	R. Km	11.60	1.47	17.04
1.3.12	On very weak Ground (3.5m high) stone column using Geo-grid wrap	R. Km	12.60	0.00	0.00
1.3.13	On strong ground (4m high)	R. Km	10.00	20.03	200.29
1.3.14	On weak ground (4m high) stone column	R. Km	13.80	12.27	169.28
1.3.15	On very weak ground (4 m high) stone column using Geo-grid wrap	R. Km	14.80	0.00	0.00
1.3.16	On strong ground (4.5 m high)	R. Km	11.20	20.86	233.63
1.3.17	On weak ground (4.5 m high) stone column	R. Km	15.00	5.69	85.40
1.3.18	On very weak ground (4.5 m high) stone column using Geo-grid wrap	R. Km	16.10	0.00	0.00
1.3.19	On strong ground (5 m high)	R. Km	12.90	14.50	187.05
1.3.20	On weak ground (5 m high) stone column	R. Km	16.80	2.13	35.73
1.3.21	On very weak ground (5 m high) stone column using Geo-grid wrap	R. Km	17.80	0.00	0.00
1.3.22	On strong ground (5.5 m high)	R. Km	14.60	8.87	129.56
1.3.23	On weak ground (5.5 m high) stone column	R. Km	18.50	5.24	96.93
1.3.24	On very weak ground (5.5 m high) stone column using Geo-grid wrap	R. Km	19.50	0.00	0.00
1.3.25	On strong ground (6 m high)	R. Km	12.20	6.06	73.94
1.3.26	On weak ground (6 m high) stone column	R. Km	20.10	0.82	16.52

Sl. No	Item	Unit	Rate as per March 2020 (in Cr)	Quantity	Amount (in INR Cr)
1.3.27	On very weak ground (6 m high) stone column using Geo-grid wrap	R. Km	21.10	0.00	0.00
1.3.28	On strong ground (6.5 m high)	R. Km	18.40	2.52	46.42
1.3.29	On weak ground (6.5 m high) stone column	R. Km	22.20	0.31	6.87
1.3.30	On very weak ground (6.5 m high) stone column using Geo-grid wrap	R. Km	23.30	0.00	0.00
1.3.31	On strong ground (7 m high)	R. Km	19.30	8.98	173.32
1.3.32	On weak ground (7 m high) stone column	R. Km	23.10	1.93	44.66
1.3.33	On very weak ground (7m high) stone column using Geo-grid wrap	R. Km	24.10	1.68	40.54
1.3.34	On strong ground (7.5 m high)	R. Km	21.90	14.71	322.20
1.3.35	On weak ground (7.5 m high) stone column	R. Km	25.70	3.87	99.37
1.3.36	On very weak ground (7.5 m high) stone column using Geo-grid wrap	R. Km	26.80	2.45	65.54
1.3.37	On strong ground (8.0 m high)	R. Km		0.00	0.00
1.3.38	On very weak ground (8.0 m high)	R. Km		0.00	0.00
1.3.39	On strong ground (> 8.0 m high)	R. Km		0.00	0.00
1.3.40	On very weak ground (> 8.0 m high)	R. Km		0.00	0.00
				Sub Total	**3031.63**
1.4	**Cutting**				
1.4.1	Cutting in all soils 2 m	R. Km	2.60	17.60	45.76
1.4.2	Cutting in all soils 2.5 m	R. Km	2.90	14.62	42.39
1.4.3	Cutting in all soils 3 m	R. Km	3.10	14.59	45.22
1.4.4	Cutting in all soils 4 m	R. Km	7.30	15.27	111.44

Sl. No	Item	Unit	Rate as per March 2020 (in Cr)	Quantity	Amount (in INR Cr)
1.4.5	Cutting in all soils 5 m	R. Km	9.60	16.20	155.48
1.4.6	Cutting in all soils 6 m	R. Km	11.80	14.60	172.25
1.4.7	Cutting in all soils 7 m	R. Km	13.90	3.48	48.37
1.4.8	Cutting in all soils 8 m	R. Km	16.00	3.42	54.71
1.4.9	Cutting in all soils 9 m	R. Km	18.10	1.97	35.70
				Sub Total	**711.32**
1.5	Tunnel (including ventilation & lighting)	R. Km	115.00	11.53	**1325.72**
1.6	Bridges	R. Km	51.10	12.99	**663.84**
1.7	RUB & ROBs				
1.7.1	RUBs	No.s	532	1.48	788.00
1.7.2	Single span ROB on cutting (322 Nos)	No.s	3.20	322.00	1030.40
1.7.3	ROB with RE wall (94 Nos) and RC box	No.s	4.20	94.00	394.80
1.7.4	Subways	No.s	355.00	1.08	383.00
1.7.5	ROB with Pile Foundation/Column (140 Nos) at approaches	No.s	12.70	140.00	1778.00
1.7.6	ROB Modification with additional ventway for Silver Line (39 Nos)	No.s	1.31	39.00	51.09
				Sub Total	**4425.29**
1.8	Civil Miscellaneous				
1.8.1	RORO - including parking for 40 trucks and ramp and ancillary facilities	LS			675.00

Sl. No	Item	Unit	Rate as per March 2020 (in Cr)	Quantity	Amount (in INR Cr)
1.8.2	Compound wall, RCC wall handrail 1m high, Fencing, Inspection PF& ladder for River bridge, Viaduct & River Bridge -special hand rail-walkway, Concertina coil, Signal & Power duct, or drain water pipe & Catch water drain, name boards indication boards etc.	LS			1545.28
				Sub Total	**2220.28**
2	**Stations**				
2.1	Type A Station at ground (incl lifts and escalators, approx parking area etc.) – Kollam, Kannur, Kasaragod	Sq.m	23000.00	3075.00	212.00
2.2	Type A Station elevated (incl lifts and escalators, approx parking area etc.) – Kochuveli, Ernakulam, Trissur	Sq.m	25250.00	3700.00	280.00
2.3	Type A Station underground (incl lifts and escalators) - Kozhikode	LS			200.00
2.4	Type B Station at ground (incl lifts and escalators) – Tirur, Chenganoor, Kottayam	Sq.m	23000.00	1535.00	106.00
2.5	Type B Station elevated (incl lifts and escalators) – NIL	Sq.m	0.00	0.00	0.00
2.6	Airport Station at Nedumbassery	Sq.m	23000.00	1090.00	25.00
2.7	OCC and Administrative Building	LS			100.00
2.8	ASS and Electrical Works	LS			50.00
				Sub Total	**973.00**
3	**All Depots & miscellaneous**				

Sl. No	Item	Unit	Rate as per March 2020 (in Cr)	Quantity	Amount (in INR Cr)
3.1	Depot at Kollam including work shop and siding track and other infra, MEP and ASS	LS			200.00
3.2	Depot at Kasaragod including work shop, system and siding track and other infra, MEP and ASS	LS			200.00
3.3	Machinery at Depot	LS			170.00
3.4	Track recording car, USFD rail testing car, Rail grinding machine, Cantenary installation car etc	LS			125.00
3.5	Accident relief Train and other equipments	LS			175.00
3.6	Track machines & track maintenance including sidings	LS			200.00
3.7	Safety & rescue and relief in tunnels and viaducts, including tunnel ventilation	LS			135.00
3.8	Automatic River water level monitoring system, rain fall monitoring system and wind speed monitoring system	LS			25.00
3.9	Small track machine and satellite depots	LS			50.00
3.10	Continuous Track monitoring by Fibre technology	LS			20.00
				Sub Total	**1300.00**
4	**Permanent way**				
4.1	Ballasted track for embankments, viaduct and yards, loop lines (passengers and RO-RO)(475Km * 5.81)+(120*2.77)	R. Km	5.81	475.00	2660.00
			2.77	120.00	332.40

Sl. No	Item	Unit	Rate as per March 2020 (in Cr)	Quantity	Amount (in INR Cr)
4.2	Ballast less track (60 Km*9.2)	R Km	9.20	60.00	552.00
4.3	Points & Crossings, Spl Layouts, RORO loops etc.	R Km	2.47	60.64	150.00
				Sub Total	**3694.40**
5	**Traction and power supply incl. OHE, ASS etc**				
5.1	Elevated Section/ At Grade Section	R KM	3.456	530.60	1834.00
5.2	Extra for Underground Section – Tunnel and Cut & Cover	R KM	0.5	32.00	16.00
5.3	OHE – (Two Depot and Sidings)	LS			60.00
5.4	Traction Substations	Nos.	60	8	480.00
				Sub Total	**2390.00**
6	**Signalling & Train Control, Communication and Ticketing & Fare Collection System**				
6.1	Signalling & Train Control (ETCS Level-2 with LTE) and Communication System -including depot & sidings	R.Km	3.57	600.00	2142.66
6.2	On Board Equipment	CAB	0.54	72.00	38.88
6.3	Ticketing & Fare collection	Stations	8.00	11.00	88.00
6.4	Misc. Ticketing & Fare Collection equipment	LS			5.50
6.5	OCC and BCC (Signalling & Train Control, Communication and Ticketing System arrangement)	LS			150.00
6.6	Signalling & Train Control and Communication Safety System	LS			100.00
				Sub Total	**2525.04**
7	**Rolling Stock**				
7.1	Rolling stock (SG) - Passenger	Set	16.00	261.00	4176.00

Sl. No	Item	Unit	Rate as per March 2020 (in Cr)	Quantity	Amount (in INR Cr)
7.2	Rolling Stock - RORO	Per Train of 40 wagons	80.00	6.00	480.00
				Sub Total	**4656.00**
8	**Staff quarters, Barracks etc…**				
8.1	Staff quarters for O&M	LS			50.00
8.2	Barracks, Training centre, camp office etc.	LS			50.00
				Sub Total	**100.00**
9	**Others**				
9.1	Shifting of Utilities	LS			
9.1.1	Shifting of powerlines	LS			240.00
9.1.2	Shifting of pipelines (KWA, Telecom..) (60 Cr for telecom)	LS			70.00
9.1.3	Shifting of minor structures	LS			23.50
9.1.4	Shifting of Rly utilities (depost works to S.Rly)	LS			260.00
9.2	Multi modal Integration (e-bus etc., for last mile connectivity)	LS			95.00
9.3	Security	Per Station	7.27	11	80.00
9.4	Noise & vibration reduction - Protection & treatment	Per Station	4.55	11	50.00
				Sub Total	**818.50**
10	**Training Facilities & Machine in training centre including Overseas training**	LS			75.00
				Sub Total	**75.00**
				Total for all items except land	**33626.97**

15.3 ESTIMATE FOR LAND & ENGINEERING WORKS

15.3.1 Salient Features of Resettlement Action Plan

One of the major cost considerations for any infrastructure project in Kerala is the land price and the Rehabilitation prices. The Land and R&R cost is determined by "THE RIGHT TO FAIR COMPENSATION AND TRANSPARENCY IN LAND ACQUISTION., REHABILITATION and RESETTLEMENT ACT 2013, herein referred to as LA Act 13. The LA Act 13 compensates the landowners for Land, buildings, trees, livestock and crops as per THE FIRST and SECOND schedule and the THIRD schedule (provision for infrastructural amenities). The salient features of Resettlement Action Plan is provided in the table below.

Table 15-5: Salient Features of Resettlement Action Plan

Sl. No.	Type of Loss	Eligible Category	Entitlement (Compensation R&R Assistance	Remarks
1.	Loss of land (Agricultural as well as Homestead/Commercial or Otherwise)	Title Holder	**a.** Land will be acquired on payment of compensation as per RFCTLARR Act 2013 hereinafter referred as Act 30 of 2013). 1. Market value specified in the India Stamp Act 1899(2 of 1899) for registration of sale deeds or agreements to Sell, in the area, where the land is situated; (or) The average sale price for similar type of land situated in the nearest village or nearest vicinity area; or nearest vicinity area; (or) Consented amount of compensation as agreed upon under sub section (2) of section 2 in case of lands for private companies or public private partnership projects, whichever is higher: Provided that the date of determination of market value shall be the date on which the notification has been issued under section II. 2. Multiplication Factor as per the Actin Urban and Rural area as notified vide GO(P) 646/2015/RD dated 03.12.2015 i.e. i. 1 on Urban area ii. 1.2 up to 10 km from outer limit of nearest urban area iii. 1.4 from 10 km-20 km iv. 1.6 from20km-30 km v. 1.8 from 30-40 km vi. 2.0 from 40 km and above	

Sl. No.	Type of Loss	Eligible Category	Entitlement (Compensation R&R Assistance	Remarks
			3. Solatium equivalent to 100 per cent of market value under section 30 of the Act &12 per cent interest shall be applicable from the date of SIA to the date of Award/taking possession whichever is earlier. (U/S)30(3). **b.** Value of assets attached to land or building to be determined as provided under section 29 of the act. **c.** The stamp duty and other fees registration fee payable for registration of the land or house allotted to the affected families shall be of the land or house allotted to the affected families shall be free from all encumbrances. The land or house allotted may be in joint name of wife and husband of the affected family. **d.** Compensation for damages sustained by reason of severing such land from his other land, **e.** Compensation for damages sustained by reason of the acquisition injuriously affecting his other property movables, or immovables. **f.** Reasonable expenses for change of residence, or business.	
2.	Affected Families whose livelihood is primarily dependent on land acquired.	Affected Family	**a.** Land will be acquired on payment of compensation as per RFCTLARR Act 2013 hereinafter referred as Act 30 of 2013 1. Market value specified in the India Stamp Act 1899(2of 1899) for registration of sale deeds or agreements to Sell, in the area, where the land is situated; (or)	

Sl. No.	Type of Loss	Eligible Category	Entitlement (Compensation R&R Assistance	Remarks
			The average sale price for similar type of land situated in the nearest village or nearest vicinity area; (or) Consented amount of compensation as agreed upon under sub section (2) of section 2 in case of lands for private companies or public private partnership projects, whichever is higher. Provided that the date of determination of market value shall be the date on which the notification has been issued under section II. 2. Multiplication Factor as per the Actin Urban and Rural area as notified vide GO(P) 646/2015/RD dated 03.12.2015. ie. ▪ 1 in Urban area ▪ 1.2 up to 10 km from outer limit of nearest urban area ▪ 1.4 from 10 km-20 km ▪ 1.6 from20km-30 km ▪ 1.8 from 30-40 km ▪ 2.0 from 40 km and above 3. Solatium equivalent to 100 per cent of market value under section 30 of the Act &12 per cent interest shall be applicable from the date of SIA to **b.** Value of assets attached to land or building to be determined as provided under section 29 of the act. the date of Award/taking possession whichever is earlier. (U/S)30(3) **c.** RR cost/ assistance shall be as per Second Schedule of the RFCTLARR Act 2013. **d.** The stamp duty and other fees registration fee payable for registration of the land or house allotted to the affected families shall be of the land or house allotted to the affected	

Sl. No.	Type of Loss	Eligible Category	Entitlement (Compensation R&R Assistance	Remarks
			families shall be free from all encumbrances. The land or house allotted may be in joint name of wife and husband of the affected family. **e.** Compensation for damages sustained by reason of severing such land from his other land, **f.** Compensation for damages sustained by reason of the acquisition injuriously affecting his other property movables, or immovables **g.** Reasonable expenses for change of residence, or business. **h.** Monthly subsistence allowance equivalent to three thousand rupees per month for a period of one year from the date of award. In addition to this amount, the SC/ST shall receive an amount of fifty thousand rupees.	
3.	Loss of House	Affected Family (Title Holder & Family without homestead land residing contineously not less than three years.	**a.** Land will be acquired on payment of compensation as per RFCTLARR Act 2013 (hereinafter referred as Act 30 of 2013). **b.** In addition to the Compensation as per the First Schedule, in Rural area a constructed house shall be provided as per the Indira Awas Yojana specifications. In Urban areas, a constructed house will be provided, which will be no less than 50 sq. mts. in plinth area. **c.** The stamp duty and other fees registration fee payable for registration of the land or house allotted to the affected families shall be of the land or house allotted to the affected families shall be free from all encumbrances. The land or house allotted may be in joint name of wife and husband of the affected family. **d.** Onetime Resettlement Allowance of rupees fifty thousand shall be given to the affected family.	

Sl. No.	Type of Loss	Eligible Category	Entitlement (Compensation R&R Assistance	Remarks
			e. Onetime financial assistance of rupees fifty thousand shall be given as transportation cost for shifting.	
4.	Loss of Employment	Employees is non-agricultural establishment	**a.** where Job are created through the project, make a provision for employment at a rate not lower than the minimum wages provided for any other law for the time being in force. on onetime payment of five lakhs rupees per affected family. Or annuity policies that shall pay not less than two thousand rupees per month per family for twenty years with appropriate indexation to the consumer. Price Index for Agricultural Laboure's.	
5.	Trees, Crops.	Title Holder	**a.** For the purpose of determining the value of the trees, plants attached to the land acquired, use the service of experienced persons in the field of agriculture, horticulture, etc.	
6.	Building	Title Holder	**a.** For determining the value of the building and other immovable Property or assets attached to the land or building, the service of a competent engineer may be considered.	

The procedure adopted for arriving at the Final award is given below.

- As per the LA act 13, the **Final Award** = **[{Compensation} + {Solatium (100% of the calculated compensation)}]**
  The Compensation = [{Market Value (determined as per the section 26)} * {Multiplication factor (1.00 to 2.00 as 1.2, 1.4, 1.6, 1.8 and 2.0) for rural areas depending upon the distance from urban areas and 1.00 for urban areas)} + {Value of assets (to be determined as per the section 29)}]. Here, Solatium means a gift or added compensation.
  The basis of the compensation amount is to arrive at the "**market price"** of the land and is done as per Clause 26 of the act at the district level, chaired by the District collector. Then this is confirmed at the state level by a committee under the chairmanship of the Chief secretary.
  Gist of Clause 26 is that the collector shall adopt the higher of (1) the market value specified in the **Indian Stamp act, 1899** (2) **average sale price of similar type of land** situated in the nearest village and (3) the **consenting amount of compensation as agreed upon under sub section (2) of section 2 in case of acquisition of lands for private companies or for public private partnership projects.**

- For the land costing, the land prices for the different categories of land along the alignment are to be compiled. However, since updated land cost is not available, average costing is suggested as illustrated in 15.2.2.2.1 and 15.2.2.2.2.

Table 15-6: Category-wise Land Prices

1	2	3	4	5	6
Sl.No.	Type of land	Unit	Rate in Crores per Hectares	Qty of land required (Ha)	Land cost (Col.4 x col. 5) Crores
1	**Land**				
1.1	Private land				
1.1.1	Wet land/ land interior with no road	Ha.	5.268 (average)	1082 (Total 1158 Ha including land for service roads)	6100.29
1.1.2	Dry land with road connectivity	Ha.			
1.1.3	Small town	Ha.			
1.1.4	Mid - Large town	Ha.			
1.1.5	Bridges, Backwaters and *Poramboku*	Ha.			
1.1.6	Station land	Ha.			

1	2	3	4	5	6
Sl.No.	**Type of land**	**Unit**	**Rate in Crores per Hectares**	**Qty of land required (Ha)**	**Land cost (Col.4 x col. 5) Crores**
1.1.7	Workshops & depots	Ha.			
1.4	Government land	Ha.	0	0	0.00
1.5	Railway land	Ha.	5.268	185	974.58
1.6	Cost of land for Rehabilitation (to be identified)				1730.29
1.7	Cost for compensation of Structures				4460.00
Total Land Cost					**13265.16**

The land costs could be brought down to this level due to the alignment which passes through the cheapest land for most of the alignment.

Verified the probable market price for the most utilized land/ the cheapest land price by reverse method as below:-

(i) Final award as per LA 13 = Rs 3 lakhs /Cent
(ii) Solatium amount= 1.5 lakhs/ cent (100% solatium)
(iii) Considering the Assets attached to land at 10%, the structures and assets price et=1.5* 0.1= 15,000.00
(iv) Therefor the price before the multiplication factor of 1.4= 1,50,000-15,000= Rs 1,35,000.00 /cent
(v) Market value of the land after deducting the 1.4 multiplication factor= 1,42,500/1.4= Rs 96,428.00 / cent. = 2.386 Cr./Ha

This is the least market price fixed considered for the project, which the LA officials feel is really conservative, if we consider the actual market prices fixed in their LA cases and the arbitration, after the final award. R&R costs at 15% of the LA Costs have been considered, which is also the subjective norm for similar projects since in a place like Kerala, the R&R prices is normally considered high due to the uniform spread of the population.

15.3.2 Land Acquisition-Guidelines from RFCTLARR ACT

The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act 2013 has been enacted with the objective of ensuring just and fair compensation and rehabilitation for the affected families due to compulsory acquisition of land for public purpose.

15.3.3 Deposit of the Estimated Cost of Acquisition

Under section 3 of the Act Clause (i), the Collector shall calculate the probable establishment charges for the acquisition at the rate of thirty percent of the cost of compensation of the proposed acquisition, which shall be deposited by the Requiring Body in the appropriate Head of account.

The Collector shall calculate contingency charges for acquisition which shall be five percent of the cost of compensation subject to a minimum of fifty thousand rupees, which shall be placed at his disposal in Treasury Savings Bank Account.

The value of land will vary from case to case depending upon the factors such as classification of land, road accessibility etc.

Determination of market value of land by District Collector is specified in section 26 to 30 of the Act 2013. Under section 73 of the Act 2013 the Award to be passed in respect of the scheduled landed property including improvements/ structures.

As such, the affected families will get the following:

1. Market value of land: Market value (MV) so calculated shall be multiplied by a multiplier factor as notified vide GO(P) no.646/2015/RD dated 03.12.2015. as shown below depending upon the location of land.

Table 15-7: Market value of Land for Urban Area

Sl. No.	URBAN AREA
1	Market value of land
2	Factors by which MV to be multiplied (**one)**
3	Value of assets/structure/improvements
4	Solatium 100% of (1x2)+3
5	Final Award (1 x 2)+3+4
6	Other compensation 12% additional value u/s 30(3).

Table 15-8: Market value of Land for Rural Area

Sl. No.	RURAL AREA
1	Market value of land
2	Factors by which MV to be multiplied as 1.2, 1.4, 1.6, 1.8 and 2.0
3	Value of assets/structure/improvements
4	Solatium 100% of (1x2)+3
5	Final Award (1 x 2)+3+4
6	Other compensation 12% additional value u/s 30(3).

2. Value of assets attached to land, buildings/Trees/Wells/Crops/ etc. as valued by relevant Govt. authority.
3. Solatium at 100%.
4. In addition, in each case, an amount calculated @ 12% p.a. from the date of notification of SIA to the date of award/ taking possession whichever is earlier u/s 30(3) of the Act.

As such, in order to expedite the Land Acquisition work for Semi high Speed Corridor from Thiruvananthapuram to Kasaragod, exclusive District level teams are to be constituted as suggested below in each district.

Table 15-9: Staff pattern of District Level Team

Sl. No.	Post	No. of Positions	Method of Appointment
1.	Tahsildar	1	On deputation from Revenue Department
2.	Deputy Tahsildar/Valuation Assistant	1	-do-
3.	Junior Superintendent	1	-do-
4.	Special Village Officer	1	-do-
5.	Village Assistant	1	-do-
6.	Surveyor Grade 1	1	-do-
7.	Draftsman	1	-do-
8.	Chainman	2	-do-
Total staff to be taken on deputation		**9**	

- **Bhoomi Rashi – A modern tool for land acquisition**

  For expediting the process of notification, settlement, Award etc. the software **''Bhoomi rashi''** being used by NHAI (or) similar software-based reporting & auto generation of forms may be evolved.

  As a part of collection of details of land to be acquired, data from Kerala State Remote Sensing & Environment Centre (KSREC), a Government of Kerala organisation, may be entrusted the job to conducted field verification, verify village survey records, FMP, etc. collected fair value details, etc.

- **Land in 11 districts under local bodies**

  The alignment passes through 11 Districts, ie. Thiruvanthapuram, Kollam, Pathanamthitta, Alappuzha, Kottayam, Ernakulam, Thrissur, Malappuram, Kozhikode, Kannur, and Kasaragod.

As per the alignment proposed, the total length of 529.45 km, out of which, 67%, of land falls under Panchayat area,15% in Municipal area and 18% in Corporation area.

In order to simplify the procedures of land acquisition for public purpose, Govt as per GO (Ms.) No. 485/2015/RD dated 23.09.2015 have issued **state policy for Compensation and Transparency in land acquisition** as provided in Section 108 of the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act 2013.

In accordance with the GO above, Govt. shall constitute a District Level Fair Compensation Committee shall have the following Members:

(i) District Collector.
(ii) Administrator for Resettlement and Rehabilitation.
(iii) Land Acquisition Officer.
(iv) Finance Officer.
(v) Representative of the Requiring Body empowered to take financial decisions its behalf.
(vi) Representative of local Self Institution of area where the land is situated.

- The District Collector will verify the title deeds & other documents and other relevant records of each parcel of land to be acquired.
- The District Govt. Pleader will scrutinize the deeds & other documents relating to the ownership and possession and give necessary recommendations to the District Collector.
- The Committee will finalize the estimate of a fair and reasonable price of the land and compensation along with the RR package to be given to the affected person/family.

The District Level Fair Compensation, Resettlement and Rehabilitation Committee shall send the estimate to the State Level Empowered Committee for approval. The Govt. shall

constitute a State level Empowered Committee which shall have the following members.

(i) Chief Secretary
(ii) Revenue Secretary
(iii) Secretary of the Administrative Department.
(iv) Law Secretary
(v) Finance Secretary.

- The State Level Empowered Committee shall approve the estimate. Upon receiving the consent of the affected persons or affected family, the District Level Fair compensation, Resettlement and Rehabilitation Committee shall submit the consent along with the minutes of its proceedings to the District Collector for finalizing the conveyance of land in terms of consent.

- The Collector, upon receiving the consent, shall cause a Sale Deed in terms of settlement arrived, to be executed and registered between himself and the affected family or affected person. On completion of the conveyance the Collector shall take possession of the land immediately.
- The designated officer of the concerned project authority will take steps to effect necessary changes in the classification of land through the Taluk Tahsildar based on the copy of registered deed obtained from the Office of the Sub Registrar.

15.3.4 Land Requirement for SilverLine

The SilverLine alignment from Thiruvananthapuram to Kasaragod (529.45 km) passes through the districts of Thiruvananthapuram , Kollam, Alappuzha, Kottayam, Kochi, Thrissur, Malappuram, Kozhikode, Kannur and Kasaragod having stations at Thiruvananthapuram, Kollam, Chengannur, Kottayam, Kochi, Thrissur, Tirur, Kozhikode, Kannur and Kasaragod apart from one at Cochin International Airport. Apart from the alignment the various structures like stations, parking facilities, traction substations, communication towers, evacuation spaces etc. requires large plots of land, the alignment is so planned that barest minimum land acquisition is involved. Land is mainly required for:

- Constructing track & structures (including route alignment),station building, platforms, entry /exit structures, traffic integration facilities etc.
- Traction Sub-stations
- Property development & commercial development of station
- Temporary construction material depots and work site
- Depot and Workshop
- Evacuation purpose etc.

15.3.4.1 Land for Viaduct

Land required for Viaduct shall be for erecting the supporting structure of the super structure generally over twin columns of diameter of 1500mm. It is generally proposed to acquire 15m width of land so that service road of required width can be provided on either side of the trestle. This will help to get access to the plots hitherto was not having any approach. This will increase the land value. The increase in the Land will increase the revenue to the Government by way registration fees. However, no permanent structures will be allowed to be constructed within distance of 15m from the centre line of the system.

15.3.4.2 Land for Station Area

Table 15-10: Land for Station Area

Sl. No	Station	Area(Ha)	Property	Ownership
1.	Thiruvananthapuram	16.77	Open land	Private
2.	Kollam	53.68	Waterlogged Land	Private
3.	Chengannur	14.18	Open land	Private
4.	Kottayam	15.51	Waterlogged Land	Private
5.	Kochi	16.97	Open land	Infopark area.
6.	Thrissur	36.48	Waterlogged Land	Private (Adjoining S.Rly Station)
7.	Tirur	13.04	Open land	Private
8.	Kozhikode (West Hill)	19.13	Open land	Private
9.	Kannur	13.75	Thinly populated	Private
10.	Kasaragod	46.66	Thinly populated	
11.	Total	246		
12.	Government Land	0	Private land 246 Ha	

15.3.4.3 Land for Traction and Receiving Station

There are 8 Traction Sub-station / 8 Receiving Sub-station which are proposed to be located on en-route at suitable interval. Land will be acquired for 8 Nos of Traction substations(TSS), 7 Nos of sectioning and paralleling post(SP) and 27 Nos of sub-sectioning and paralleling post (SSP). It is proposed to acquire a total of 10.87 Ha. of land for this purpose.

15.3.4.4 Land for Depot

Main Depot and workshop is located at Kollam for which 24 Ha. of private land is identified for a full-fledged maintenance depot. Similarly, a depot is planned at Kasaragod for which 20 Ha. of private land identified.

15.3.4.5 Land Requirement for Alignment

The alignment passes through Viaduct, Tunnel, Cutting, Bank, Cut & Bank and Cut & Cover as detailed below:

Table 15-11: Land Requirement for Alignment

Sl.No	Description	Length (km)	Width (m)	Total Land (Ha)
1.	Viaduct	88.41	15	81.57
2.	Tunnel	11.52	-	-
3.	Bank	292.72	20	673.0
4.	Cut & Bank			Balancing
5.	Cutting	101.73	25	251.25
6.	Cut & Cover	24.78	25-40 m	76.21
			Total	**1082.0**

15.3.4.6 Land for Temporary Construction Depot

During construction period, huge quantities of construction materials like reinforcement bars, cement, steel sections, shutters, pre-cast segments, etc. are to be stored. Sufficient land is required for storage of these materials. It is proposed to have temporary Depots in the proposed station areas.

15.3.4.7 Land from Railways

Railway land will be required for the SilverLine alignment running parallel to the existing Southern Railway track between Tirur and Kasaragod.

15.3.4.8 Total Permanent Land Requirement

Table 15-12: Requirement of Total Permanent Land

Sl. No	Type of alignment	Route Length (Km)	Width of the Land to be acquired (m)	Land area required (Hectares)
1.	Viaduct	88.41	15	81.57
2.	Cut & Cover	24.78	25 to 40 m	76.21
3.	Cut & Bank			Balancing
4.	Tunnel	11.52	-	
5.	Bank	292.72	20	673.0
6.	Cutting	101.73	25	251.25

Sl. No	Type of alignment	Route Length (Km)	Width of the Land to be acquired (m)	Land area required (Hectares)
7.	Approaches of Tunnels & Waterway bridges			
8.	Land of TSS & RSS	-	-	10.9
9.	Land of Emergency Evacuation and S & T etc.			
10.	Station (10 Nos.)			246
11.	Depots (2)			44
			Total (in Ha)	**1382.3**

15.3.4.9 Relocation / Resettlement

The project involves the relocation of a few shops & commercial & residential buildings. Reasonable Compensation for the relocation of these affected structures shall be paid. The alignment is so designed to have the minimum acquisition and have least disturbance to the public.

15.3.5 Alignment

Total length of alignment works out to 529.45 Km. The underground section of 24.78 km which is proposed to be constructed by Cut and Cover method. Cost of cut and cover is taken as 33.3 Cr. for weak/normal ground and 28.5 Cr./km for strong ground. Length of 9.7 km is proposed to be constructed using NATM tunelling method, cost of which is taken as 78.5 Cr./km. 88.4 km of alignment will be elevated. Cost of viaduct works out to 33.5 Cr./km for 8m high viaduct and 38.8 Cr./km for 10 m high viaduct, 39.3 Cr./km for 15 m high viaduct and 50.0 Cr./km for 20 m high viaduct.

Cost of at grade alignment on all terrain and for cutting in all soil condition is given in table below.

Table 15-13: Cost of At-grade Alignment and for Cutting (in INR Cr.)

Sl. No	Item	Unit	Rate as per March 2020 (in Cr)	Quantity	Amount (in INR Cr)
1	**Alignment and Formation**				
1.1	**Cut and cover**				
1.1.1	Upto 20m depth normal/weak ground	R. Km	33.30	4.43	147.56
1.1.2	Upto 20 depth strong ground	R. Km	28.50	10.60	302.00
1.1.3	**NATM method**	R. Km	78.50	9.76	766.28
				Sub Total	**1215.83**
1.2	**Viaduct**				
1.2.1	8 m high viaduct	R. Km	33.50	20.15	675.04
1.2.2	10 m high viaduct	R. Km	38.80	14.06	545.47
1.2.3	15 m high viaduct	R. Km	39.30	40.14	1577.69
1.2.4	20 m high viaduct	R. Km	50.00	14.06	702.92
				Sub Total	**3501.12**
1.3	**Cutting**				
1.3.1	Cutting in all soils 2 m	R. Km	2.60	17.60	45.76
1.3.2	Cutting in all soils 2.5 m	R. Km	2.90	14.62	42.39
1.3.3	Cutting in all soils 3 m	R. Km	3.10	14.59	45.22
1.3.4	Cutting in all soils 4 m	R. Km	7.30	15.27	111.44
1.3.5	Cutting in all soils 5 m	R. Km	9.60	16.20	155.48
1.3.6	Cutting in all soils 6 m	R. Km	11.80	14.60	172.25
1.3.7	Cutting in all soils 7 m	R. Km	13.90	3.48	48.37
1.3.8	Cutting in all soils 8 m	R. Km	16.00	3.42	54.71
1.3.9	Cutting in all soils 9 m	R. Km	18.10	1.97	35.70
				Sub Total	**711.32**
1.4	Tunnel (including ventilation & lighting)	R. Km	115.00	11.53	**1325.72**

15.3.6 Station Building

The cost includes general services & MEP services at the stations (but excludes the cost of tunnel), lifts & escalators, which have been considered separately under respective items. Cost per station approximately works out to 70.27 Cr. for Type A at grade stations and 35.0 Cr. for Type B at grade stations. For type A elevated stations cost id Rs. 93.0 Cr. For Type B elevated station. For underground stations, cost works out to be approximately Rs. 200 Cr. Cost of OCC and administrative buildings works out to 100 Cr. Cost of ASS & MEP arrangements has been taken separately as 5 Cr./km.

For the Airport station, approximate cost has been worked out as 25.0 Crore.

15.3.7 Permanent Way

For underground section, ballastless track has been planned. However, for at-grade section, ballasted tracks have been proposed. Rates have been worked out a fresh using market value.

Table 15-14: Cost for Permanent Way

Sl. No.	item	Unit	Rate (in Cr/Km)	Basis of rates
2	**Permanent way**			
2.1	Ballast less track for tunnel	R. Km	9.2	Rate worked out based on Kochi Metro rates+ Additional rate required for high speeds of 200 to 250 Kmph
2.2	Ballasted track for embankments, viaduct	R. Km	5.81	
2.3	Ballasted Loop line	R. Km	2.77	

15.3.8 Utility Diversion

The provision of utility diversion has been made which works out to 333 Cr. over the entire length and involves shifting of powerlines, pipelines and other structures. The cost of shifting of powerlines is estimated to be INR 240 Cr., shifting of pipelines such as for KWA – INR 10 Cr., INR. 60 Cr for telecom, shifting of minor structures is estimated to be INR 23.50 Cr. Apart from the above, as deposit to S.Rly, for shifting of railway utilities, INR 260 Cr., has been earmarked.

15.3.9 Environmental and Social Impact Assessment

Detailed R&R and EIA study has been taken up at DPR stage and have taken 50 Cr. (Net 100 Cr.) as Lump sum for Environment & Social Management Plan and R&R cost as stated below.

Rehabilitation and Resettlement (R&R) Cost

For the families who express their willingness to move/resettle at nativity, constructed houses in colonies proposed to be developed by K-Rail. land parcels are proposed to be acquired separately. On these land, multi-storeyed housing complexes with all amenities are proposed to be constructed.

Approximate number of families out of affected 7000 houses proposed to be dismantled, who may be willing to move to readily built-up apartment may be around 1400 households (20%).

For costing of 700 houses at 10 locations, approximately 100 Ha of land is proposed to be acquired at convenient towns. Three storeyed apartments are planned to be constructed as per the estimate below.

a) Cost of land: 100 x 5 Cr./Ha = 500 Cr.
b) Cost of Construction: 1400 x 0.7 Cr./Ha = 980 Cr.
c) Exterior area development, roads, water supply, landscape etc. = 250 Cr.
d) From the above, the total cost is estimated to be 1730 Cr.
e) All items = 1730 / 11535 = approximately 15%

Hence for R&R, approximately 15% of land cost is proposed to be provided in the detailed estimate.

15.3.10 Land Acquisition – Way Forward

Kerala State Remote Sensing & Environment Centre (KSREC) a Govt. of Kerala enterprise may be assigned the work of identifying the survey numbers of the land over the entire Corridor using the field data readily available with them and the Field Measurement (FM) stretches available with the Department of Revenue.

Land Acquisition cells may be formed at each of the 11 districts through which SilverLine traverses and Posted with adequate staff (Both regular and on contract) to expedite the Land Acquisition and resettlement procedures.

For expediting the process of notification, Settlement, award, etc., the software “Bhoomi rashi” being used by NHAI or similar software based reporting & auto generation of forms/ procedures may be evolved.

15.4 TRACTION AND POWER SUPPLY

The Cost of Traction & Power supply has worked out to 3.46 Cr. Per km for both elevated & at grade section. For underground section an extra cost of 0.5 Cr per km has been taken. Cost of OHE in Depot and sidings works out to 60 Cr. Cost of RSS/TSS has been taken as 60 Cr. per RSS/TSS, including cable cost. Revised cost as on March 2020 works out to 2390 Crore.

The cost of power supply and ventilation arrangement of tunnel is included in the overall tunnel cost.

15.5 ROLLING STOCK

Cost of Rolling stock works out to 4656 Cr. including passenger, RORO and infrastructure facilities for RORO.

15.6 DEPOT & TRACK MACHINES

2 Depots have been proposed for the corridor i.e. one Depot at Kollam and another one at Kasaragod. Revised cost of both the depots and track equipment works out to

1560 Cr. This cost includes Track recording car, USFD rail testing car, Rail grinding machine, Catenary installation car, Accident relief Train and other equipments, Track machines & track depot including sidings, safety & rescue and relief in tunnels and viaducts, including tunnel ventilation, Automatic River water level monitoring system, rain fall monitoring system and wind speed monitoring system and Track machine including continuous track monitoring by fibre technology depots.

15.7 TAXES AND DUTIES

It is estimated that taxes and duties for SilverLine speed rail corridor between Thiruvananthapuram and Kasaragod will work out to 5135 Cr at March 2020 prices.

15.7.1 Custom Duty, Central GST, State GST taken for Taxes and Duties

The taxes and duties in respect of imported materials consist of Custom Duty (CD), Customs Cess and Integrated Goods and Services tax (IGST). The SilverLine Project shall be eligible for availing concessional project import duty under chapter 98.01 of the Custom Tariff Act. Accordingly, the effective Customs Duties works out to 24.49% (Basic CD 5% & Cess 10% on Basic Customs Duty and 18% IGST on total import value including the basic duty and cess). For the indigenously manufactured items, the Goods and Services tax (GST) rate applicable on works contract at 12% has been considered for all procurements other than rolling stock, GST rate of 12% applicable for rolling stock and GST rate of 18% applicable for services of consulting engineers and other services has been considered.

Accordingly, the taxes and duties rates used in the preparation of the detailed cost estimate are tabulated below;

1	GST on civil and systems procurement activities of semi-high speed rail works and Rolling Stock	12.00%
2	***Tax Leviable on Import***	***Duty***
A	Assessable Value	100.00
B	Basic Custom Duty (BCD – 5 %) + Customs Cess (10% of Basic Duty)	5.50
C	Total (A+B)	105.50
D	IGST (assumed to be levied @ 18.00 % on 'C')	18.99
E	***Effective rate of Custom Duties on Assessable Value***	24.49
3	GST on Design, PMC	18.00%

DETAILED PROJECT REPORT

SEMI HIGH SPEED RAIL CORRIDOR
THIRUVANANTHAPURAM TO KASARAGOD

VOLUME II - MAIN REPORT
(PART D)

CHAPTER 16
TRANSIT ORIENTED DEVELOPMENT

16 TRANSIT ORIENTED DEVELOPMENT (TOD)

16.1 INTRODUCTION

Transit Oriented Development or TOD is densification around nodes and corridors of public transit so that households can live in close proximity to their jobs. It enables them to walk to work or use public transit when required instead of depending on private vehicles.

TOD is based on the concept of mixed land use where in the variegated users are located in proximity to each other so as to foster a holistic approach towards urban conglomeration. It envisages a co-existence of residential, commercial and institutional pockets as self-contained units and with improved standards of living with harmony in the society.

Transit Oriented Development can help:

- Reduce the need to commute which also meets guidelines of sustainable transport.
- Enable healthy and active lifestyles by creating walkable communities.
- Improve access to affordable housing for all income groups.
- Increase job opportunities for low-income people and working families.
- Reduce traffic and congestion in the streets.
- Reduce pollution caused by vehicles.
- Improve revenue of city bringing in more housing and jobs.
- Enable efficient use of available land.

The above objectives can be achieved by

- Integrating transport networks with the newly formulated zone of activity
- All activity zones to locate within ½ km for free and quick access by walking or by bicycle.
- Blooming of activities, both during day and night.
- Creation of space for recreation, walking track etc.
- Signages, illumination, relaxation area etc. to have a peaceful urban realm for the society.

Initially TOD can occur surrounding the station area, approach roads to station etc. due to better connectivity and accessibility. TOD may be formed near aggregator stations, RORO loading/unloading points as well to a large extent.

16.2 NATIONAL TRANSIT ORIENT POLICY

(i) As the cities are experiencing rapid growth, transit systems like metro rail, BRTS, etc. are being implemented to cater to the growing travel demand. It

has thus become inevitable to have TOD for all such cities which have an existing mass transit system or are planning to do so.

(ii) It is the responsibility of the state government to manage the urban spaces, however a National TOD policy would serve as guidelines and play a catalytic role in formulating state/ city level policies for promotion of transit-oriented development.

(iii) National TOD policy shall be a guiding document for the Central Government ministries/ departments/ agencies to ensure that their schemes, policies, etc. encourage TOD in cities, especially those with upcoming mass transit systems.

(iv) This shall support states and cities to recognize public transport infrastructure as the core around which the future expansion of urban areas should be planned and the investments in public transport be directed accordingly.

16.3 VISION OF TOD POLICY

The vision of the policy is three-fold:

(i) Enable Transformation: to assist in transformation of cities from private vehicle dependent city to public transport-oriented development.

(ii) Accessible Public Transport: to promote the usage of public transport by making it accessible, encourage green mobility by encouraging people to walk and cycle and at the same time curb pollution and other negative impacts of motorization.

(iii) Compact Walkable Communities: to create livable and affordable communities, which are compact and walkable.

16.4 PRINCIPLES OF TOD

TOD focuses on compact mixed-use development around transit corridor such as metro rail, BRTS etc. International examples have demonstrated that though transit system facilitates transit-oriented development, improving accessibility and creating walkable communities is equally important. Based on the objectives of National Urban Transport Policy, this TOD policy defines 12 Guiding Principles and 9 Supportive tools, as shown in Figure 16.1 and 16.2, for realizing the objectives of TOD.

Figure 16-1: TOD Principles

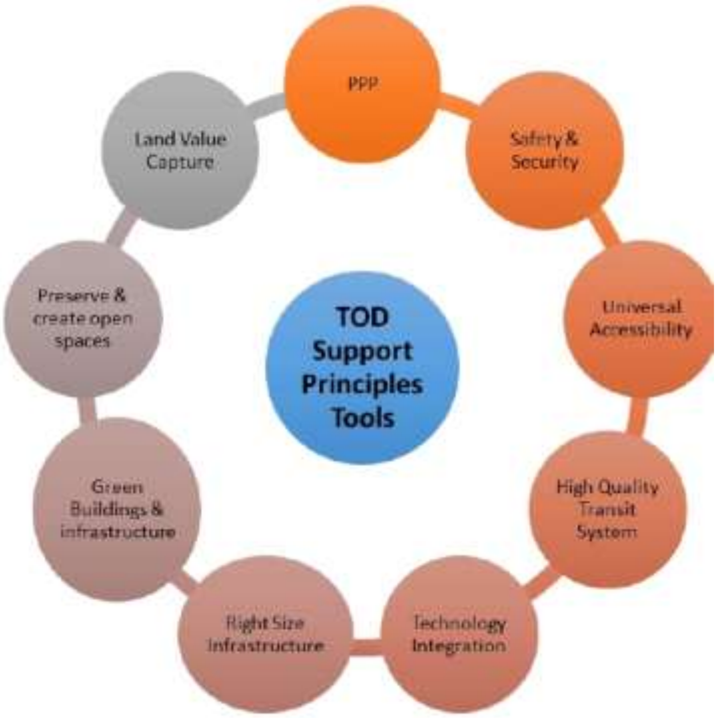


Figure 16-2: TOD Support Principle Tools

16.5 TOD TO CATER TO MOBILITY

TOD shall cater to the principles of city mobility & planned development as detailed below:

(i) MUST PLAN OUR CITIES AND THEIR MOBILITY TOGETHER: The way our cities are built determines mobility needs and how they can be met. Development, urban design and public spaces, building and zoning regulations, parking requirements, and other land use policies shall incentivize compact, accessible, livable, and sustainable cities.

(ii) MUST PRIORITIZE PEOPLE OVER VEHICLES: The mobility of people and not vehicles shall be in the center of transportation planning and decision-making. Cities shall prioritize walking, cycling, public transport and other efficient shared mobility, as well as their interconnectivity. Cities shall discourage the use of cars, single-passenger taxis, and other oversized vehicles transporting one person.

(iii) ENSURE THE SHARED AND EFFICIENT USE OF VEHICLES, LANES, CURBS, AND LAND: Transportation and land use planning and policies should minimize the street and parking space used per person and maximize the use of each vehicle. We discourage overbuilding and oversized vehicles and infrastructure, as well as the oversupply of parking. Shared vehicles include all those used for hire to transport people (mass transit, private shuttles, buses, taxis, auto-rickshaws, car and bike-sharing) and urban delivery vehicles.

(iv) ENGAGE WITH STAKEHOLDERS: Residents, workers, businesses, and other stakeholders may feel direct impacts on their lives, their investments and their economic livelihoods by the unfolding transition to shared, zero-emission, and ultimately autonomous vehicles. We commit to actively engage these groups in the decision-making process and support them as we move through this transition.

(v) PROMOTE EQUALITY: Physical, digital, and financial access to shared transport services are valuable public goods and need thoughtful design to ensure its use is possible and affordable by all users, regardless of age, gender, race, ethnicity, income, ability, or other characteristic/identity.

(vi) LEAD THE TRANSITION TOWARDS A ZERO-EMISSION FUTURE AND RENEWABLE ENERGY: Public transportation and shared-use fleets will accelerate the transition to zero-emission vehicles. Electric vehicles shall ultimately be powered by renewable energy to maximize climate and air quality benefits.

(vii) ENSURE FAIR USER FEES ACROSS ALL MODES: Every vehicle and mode should pay their fair share for road use, congestion, pollution, and use of curb space. The fair share shall take the operating, maintenance and social costs into account.

(viii) AIM FOR PUBLIC BENEFITS VIA OPEN DATA: The data infrastructure underpinning shared transport services must enable interoperability, competition and innovation, while ensuring privacy, security, and accountability.

(ix) WORK TOWARDS INTEGRATION AND SEAMLESS CONNECTIVITY: All transportation services should be integrated and thoughtfully planned across operators, geographies, and complementary modes. Seamless trips should be facilitated via physical connections, interoperable payments, and combined information. Every opportunity should be taken to enhance connectivity of people and vehicles to wireless networks.

(x) ENSURE THAT AUTONOMOUS VEHICLES (AVS) IN DENSE URBAN AREAS SHOULD BE OPERATED ONLY IN SHARED FLEETS: Due to the transformational potential of autonomous vehicle technology, it is critical that all AVs are part of shared fleets, well-regulated, and zero emission. Shared fleets can provide more affordable access to all, maximize public safety and emissions benefits, ensure that maintenance and software upgrades are managed by professionals, and actualize the promise of reductions in vehicles, parking, and congestion, in line with broader policy trends to reduce the use of personal cars in dense urban areas.

16.6 TRANSIT ORIENTED DEVELOPMENT ESSENTIALS

- High quality public transit network
  - Bus Rapid Transit (BRT)
  - Metro
  - Commuter Rail
- Intensification of land utilization for higher Household per sq.km, People per sq.km and Jobs per sq.km
- Affordable housing within proximity to public transit to enable lower income families to access jobs.
- Pedestrian and bicycle infrastructure to ensure access to public transit (last mile connectivity).
- Mix of activities and uses to reduce distances travelled for work or for recreation.
- Urban design that enhances quality of the built and open spaces for all user groups

16.7 APPROACH FOR TOD IMPLEMENTATION

16.7.1 SilverLine Classification

TOD in SilverLine is classified in three categories,

(1) Proximity Station Zone (PSZ): The Influence area will be 500 meters on both side of 10 nos of Main Station defined in table 16.1.

(2) Non-Proximity Station Zone (NPSZ): The Influence area will be between 500 m-1000 m on both side of 10 nos of Main Station defined in table 16.1.

(3) Non-Station Zone (NSZ): The influence area will be identified land other than above defined zones. This will be a standalone Commercial Development zone irrespective of distance from Silverline Stations.

The TOD development will be done for the below locations adhering to National TOD Policy. The Value Capturing Financing tools (except Green Surcharge on Fuel, Surcharge of private vehicle tax & Additional stamp duty & registration fee for property) will be applicable in influence zone (1000 m around the stations) of all stations irrespective of above classifications.

Table 16-1:Classification of Stations

S. No.	SilverLine Station	Station Location	Type of City
1	**Thiruvananthapuram**	City	Municipal Corporation
2	**Kollam**	Outside city	Municipal Corporation
3	**Chengannur**	City	Town panchayats & Municipalities
4	**Kottayam**	City	Town panchayats & Municipalities
5	**Ernakulam**	City	Town panchayats & Municipalities
6	**Kannur**	City	Municipal Corporation
7	**Thrissur**	City	Municipal Corporation
8	**Tirur**	City	Town panchayats & Municipalities
9	**Kozhikode**	City	Municipal Corporation
10	**Kasaragod**	City	Town panchayats & Municipalities

16.7.2 Influence Zone

(i) The area in the immediate vicinity of the SilverLine station, i.e. within a walking distance, having high density compact development with mixed land use to support all basic needs of the residents is called the influence zone of a SilverLine station/ corridor.

(ii) The area of influence, where the TOD is planned for implementation, should be demarcated and notified through master plan and local area plans before implementation. The area needs to be first de-notified and then notified under the Development Authority responsible for development of the TOD pockets or otherwise each ULB to prepare a Zonal Plan within their Masterplan. This would require each Master Plan to be re-approved following the due statutory process. If in any case the TOD is to be implemented in a phased manner, the influence area of the TOD can also be notified in phases. The principles for delineating the influence area should be clearly indicated so that there is no speculation or confusion regarding the influence zone.

16.7.3 High Density Compact Development

(i) TOD promotes densification in the influence area by providing higher Floor Area Ratio (FAR)/ Floor Space Index (FSI) and higher population & job density as compared to the area around and beyond the influence areas. To ensure sustainable development and based on Kochi Metro TOD model, the minimum FAR should be 300 - 500%, and can be higher, depending on the city size. This will promote higher concentration of people within the walking distances of transit station, thereby increasing the ridership of the public transport and resulting in increased fare revenue, pollution and congestion reduction.

(ii) It is not necessary to keep the density and FAR norms consistent for the influence areas across the city. It can vary depending on the infrastructure available, land use zoning, transit capacity etc.

(iii) Silverline TOD will follow green building norms, adopt renewal sources of energy such as solar and waste to energy options, adopt rain water harvesting and ground water recharge techniques, which would encourage water conservation, utilization of clean energy and promote sustainable waste management so as to make them self-sustaining through efficient use of resources and infrastructure.

16.7.4 Mixed Use Development

(i) Mixed land use will be stipulated for development/ redevelopment in the Silverline TOD zone as it would reduce the need for travel by providing most of the activities such as shopping, entertainment and public amenities such as schools, parks, playgrounds, hospitals etc. within the walking distance of the residents. It would also improve the accessibility of the transit facilities and at the same time link origins and destinations, i.e. residences with workplaces or activity nodes. This would ensure better utilization of transit fleet by distributing loads in both directions, rather than creating unidirectional peak hour flows.

(ii) A blend of land-uses help in the optimization of physical infrastructure and resources, as all components like roads, parking, water, sewerage etc., remain functional at all times of the day.

(iii) The TOD benefits cannot be realized with the kind of developments that encourage the use of personalized vehicles. It is therefore imperative to restrict developments such as low-density housing, low-rise development, warehouses, petrol pumps/CNG stations, cremation ground and surface/Multilevel parking etc. in the influence area.

(iv) To promote mixed use development, following strategy must be followed,

a. The minimum plot area in the influence zone should be defined.
b. The developer may, however, be permitted to undertake construction in a phased manner.
c. In case, the individual landowners want to collaborate for development as per TOD norms, necessary provisions may be made to facilitate it.
d. The landowner(s) may also be permitted to collaborate with developers in case they lack the required experience and institutional & financial capacity to undertake such development as per TOD norms.
e. The minimum percentage of built up area for housing, commercial and other amenities should be fixed.

16.7.5 Mandatory and Inclusive Housing

(i) The proposed TOD influence zones should fix a minimum percentage (30% or higher) of allowed FAR for affordable housing (for example up to 60 sq.mt. area) in all development/redevelopment in the influence zones.

16.7.6 Multimodal Integration

(i) The influence area should have high quality integrated multimodal transport system for the optimum use of the facilities by the residents/users.

(ii) The system should have seamless physical connectivity, information integration and fare integration across modes so that the first and last mile connectivity does not become a bottleneck in the use of public transit systems by the citizens.

(iii) The citizens should have barrier free access to all the required amenities in the transit system as well as around the transit centres

(iv) The hierarchy of the facilities at the transit system should prioritize pedestrians followed by bicycle, feeder buses, drop-off facilities and park and ride facility in the given order.

(v) Intermediate Public Transport (IPT), Non-Motorized Transport (NMT) and feeder buses perform a significant role in providing first and last mile connectivity to the populace beyond the influence zone. To ensure that the area around the transit station remain congestion free and to facilitate easy transfers, it is important to provide adequate parking and pickup/ drop-off

facilities for the above modes at suitable locations at the stations and in the influence zone.

16.7.7 Focus on Pedestrians, Cyclists and NMT Users

(i) The influence zone should have development in smaller blocks with a finer street network having provision for pedestrians, bicyclists and NMT users. This will create a grid of small, traversable blocks which has sidewalks and amenities like lighting and information signage etc. and ensure accessibility of the transit stations by pedestrians and cyclist.

(ii) Universal Accessibility: All streets should be designed to meet or exceed the minimum standards stipulated for barrier free environment by Government of India1 to ensure universal accessibility for people with reduced mobility including visually and hearing impaired persons.

16.7.8 Street Oriented Buildings and Vibrant Public Spaces

(i) Retail and other 'active uses' should be supported on the ground floor along the main streets, key intersections, stations and parking garages to ensure high quality pedestrian environments.

(ii) To promote natural surveillance of public spaces, all boundary walls and setbacks should be removed, and buildings should be permitted up to the edge of the street. Also, the orientation of the buildings should be such so as to face the pedestrian facilities.

(iii) Ground floor should support commercial activity, with at least 50% un-tinted transparent frontage.

(iv) Street Vendors: TOD aims at inclusive development wherein all users of the system are benefited. The street vendors are the eyes of the streets; hence the designated spaces should be created for them while designing the streets.

(v) Preserve Open Spaces: All open areas such as amenity spaces, green spaces, playgrounds, parks and natural areas should be preserved as part of TOD.

16.7.9 Managed Parking

(i) To discourage the use of private vehicles and to manage parking in TOD, it is essential that the supply of the parking is reduced and made expensive within the influence zone.

(ii) On-street parking should be prohibited within 100 m of the transit station, except for freight delivery and pickup or drop-off of the differently abled.

(iii) Parking should not be allowed in a manner wherein the aesthetics of the city is lost. On-street parking should be avoided.

16.7.10 TOD around Silverline Stations, Zone: A

The proposed stations for zone A are Thiruvananthapuram, Ernakulam & Thrissur. This zone is further sub divided into,

(A) Proximity zone (PZ), where influence zone will be 250 m in radius from Silverline stations. This zone is envisaged to be predominantly non-residential mix use in character with residential component essentially less than 30% of the consumed FAR. The rest of the FAR may be consumed by commercial retails, offices, entertainment uses, flatted industries etc.

(B) Non-Proximity zone (NPZ), where influence zone will be between 250 m- 500m from Silverline stations. This zone envisaged to be pre-dominantly residential mix use zone in character with residential component essentially equal to more than 50% of the consumed FAR.

The proposed TOD activity mix in TOD zone area will include the following:

- **Commercial**
  - Offices
  - Restaurants
  - Hotels Retail
  - Shopping Centres/Malls
- **Residential**
  - Plotted development
  - High rise vertical mixed-use typology
  - High rise housing enclave typology
  - Walk-ups
- **Social amenities**
  - Primary health centre
  - Pre schools
  - Primary schools
  - Secondary schools
  - Community centres
  - Women welfare centres
  - Resident’s welfare association building
  - Sacred location
- **Work Canters**
  - Workshops
  - Mixed use development with non-polluting activities
  - Flatted factories
- **Social facilities**
  - NMV stops (cycle rickshaws and hired cycle stands)
  - Electric substation
  - Sewerage treatment plant
  - Water harvesting mechanisms

- Water distribution tanks

16.7.11 TOD along the Silverline Corridor between the Stations, Zone: B

Normally, TOD influence zone along the Silverline corridor between the stations can be further classified into following,

1) **Core Area**
    - **Ideal Land use mix and mixed land use development:**
        - Residential: High Intensity
        - Commercial/ Office: Medium Intensity
        - Mixed Use
        - Supporting retails & services
    - **Transit mode function:**
        - Bicycle Lanes
        - Pedestrian Networks
        - Intermediate transportation supported by non-motorised vehicles
        - Limited parking lots
2) **Commercial Zones**
    - **Ideal Land use mix and mixed land use development:**
        - Employment (commercial, office, industrial, institutional): High Intensity
        - Supporting retail & services: Medium Density
        - Residential: Minimal
    - **Transit mode function:**
        - Parking Lots, if required
        - Pedestrian Networks
        - Bicycle Lanes
        - BRT and Bus Stops
        - Intermediate transportation supported by motorised vehicle
3) **Neighbourhood**
    - **Ideal Land use mix and mixed land use development:**
        - Residential: Medium Intensity
        - Employment (commercial, office, industrial, institutional): Mediu m Intensity
        - Supporting retails & services
    - **Transit mode function:**
        - Pedestrian Networks
        - Bicycle Lanes
        - Considerable Multi - level Parking Areas
        - Intermediate transportation support by non-motorised vehicles
4) **Peri - urban Area**
    - **Ideal Land use mix and mixed land use development:**

- Commercial: High Intensity along TOD
- Residential: Medium Intensity in inner region
- Mixed Use including compatible institutional use

- **Transit mode function:**
  - Transition to higher density and greater mix of uses close to the transit source
  - BRT and Bus Stops
  - Green Interconnected Pedestrian Network
  - Considerable Multilevel parking areas.

16.8 VALUE CAPTURE FINANCING

16.8.1 Introduction

Value Capturing as practiced widely different VCF methods while Haryana and Gujarat based on the principal that private land & buildings benefits from the public investment in Infrastructure and policy decisions of Government (eg. change in land use or FSI). Appropriate VCF tools can be deployed to capture a part of the increment in value of land and buildings. In turn, these can be used to fund projects being set up for public by Central/State Governments and ULBs. This generate a virtuous cycle in which value is created, realized and captured which can be used again for project investment.

The rapid urbanization in India has led to increased demands for providing state-of-art infrastructure in urban local bodies(ULBs) and the ULBs are continuing looking for new source of fund in order to meet the requirements of creating and upgrading infrastructure. Similarly, the Ministry & Departments of Government of India have to make lumpy investment for Infrastructure development at the national & regional levels.

Land is the most fundamental asset that is owned and managed by States/ULBs and is a resource to generate revenues. Traditionally, states/ULBs has relied on the direct sale of lands to raise funds, which is a less efficient form of resource mobilization, as compared to the value capturing. In some cases, States/ULBs are using different Value Capture Methods to raise resources, especially in urban areas. For example MMRDA & CIDCO has used different VCF methods while Haryana and Gujarat has successfully used land pooling schemes, where owners agreed to exchange their lands for infrastructure services. The Details of Value Capturing methods being used by states/ULBs is provided in Table 16.3.

VCF seeks to enable States and city governments raise resources by tapping a share of increase in value of land and other properties like buildings resulting from public investments and policy initiatives, in the identified area of influence. The VCF is constituted of four steps:

Figure 16-3: Steps of VCF

16.8.2 Initiative

With a view to develop a comprehensive VCF framework so that it can be used efficiently and optimally across the country as a method of financing ongoing Urban Transformation, the MoUD has recently come out with a policy framework for an innovative resource mobilization through Value Capture Financing (VCF). The VCF policy framework will work as a guide to State and city governments in assessing the scope of resource mobilization, identifying the area of influence of proposed projects and optimizing resource mobilization.

The different instruments of VCF as proposed in VCF Policy framework are:

(1) **Land Value Tax (LVT) –** Considered the most ideal Value Capture tool which apart from capturing any value increment, helps to stabilize property prices, discourage speculative investments and is considered to be most efficient among all VC methods. This is based on land records, valuation, assessment and revenue collection and enables levy for rural and urban land. Maharashtra & Tamil Nadu, through state laws, have expanded the scope of this mechanism

to cover urban land also. Globally, LVT is widely used in Denmark, Australia and New Zealand.

(2) **Fee for changing land use** – capturing gains from changes in land use from commercial to industrial, residential to industrial, residential to commercial, agricultural to non-agricultural.

(3) **Betterment levy:** One-time upfront charge on land value gain caused by public infrastructure investment. This occurs in two forms, (a) revenue source improvement schemes (b) for specific projects. MMRDA, Hyderabad Municipal Corporation has implemented the same.

(4) **Development charges (Impact Fees):** This is area based and link the development charge to the market value of land by carrying out periodic revisions. This is the most widely used land based fiscal tool in states. States like Andhra Pradesh, Gujarat, Maharashtra, Tamil Nadu and Madhya Pradesh levy the impact fee and collect it upfront while granting development permission.

(5) **Transfer of Development Rights (TDR)** – used for trading development rights and thereby aiming to recover monetary compensation that would have been lost due to heritage conservation or land being utilized for social causes such as open spaces and affordable housing etc. Maharashtra, Gujarat and Karnataka have enabling laws for using TDR for developing open space & promoting affordable housing. Open spaces or cultural resources are the way to compensate the property owners for loss in revenue on their properties. In New York city, TDR is given for preservation of Heritage Landmark buildings.

(6) **Premium on relaxation of Floor Space Index and Floor Area Ratio –** to allow for additional development rights beyond the permissible limits in the State Town Planning Laws & Regulations. Sale for additional floor area ratio (FAR) is an important value capturing tool in Brazil & France. Maharashtra, Gujarat, Tamil Nadu & Karnataka are widely using this tool to allow additional development rights.

(7) **Vacant Land Tax:** Applicable on those land owners who have not yet initiated construction on their land. Andhra Pradesh, Greater Hyderabad Municipal Corporation imposes a tax of 0.5% of registration value of the land if not used exclusively for agriculture purpose or vacant without a building.

(8) **Tax Increment Financing (TIF) –** to capture a part of the increase in land value either due to planned improvement due to specific projects. This is one of the most popular VC tool in many developed country specially in United States. In TIF, the incremental revenues for future increases in property tax or a surcharge on the existing property tax rate is ring fenced for a defined period to finance some new investment in the designated area. TIF is especially useful to finance new investment in existing habitations. Some of the Smart City proposals have planned for TIF in their area-based developments (ABD).

(9) Land Acquisition, Zoning Relaxation & Development: Acquiring and developing land could be adopted as useful VC method to mobilize resources. In Hyderabad, impact fees are levied on all new developments within one km wide growth corridor on both sides of the "Outer Ring Road (ORR)". Another innovative road widening scheme is being implemented in Hyderabad in which the Municipal Corporation gives additional FAR and Relax zoning for property owners who give land free of cost for Road widening.

(10) Land Pooling System (LPS): A form of Land Procurement where all land parcels in an area are pooled, converted into a layout, infrastructure developed, and a share of land in proportion to original ownership returned as a reconstituted parcels. In India, state such as Gujarat and Haryana has used land assembly programs where owners agreed to exchange their barren lands for infrastructure-serviced smaller plots. Gujarat has used these tools to guide the development of Ahmedabad City and its surrounding infrastructures. The state of Andhra Pradesh has used the LPS to get land for Amravati, its new Capital City. Such LPS are also a common feature in countries like Japan and Germany.

16.8.3 Value Capturing Methods and Scale of Intervention

Table 16-2: VCF & Scale of Intervention

S.No	Value Capture Method	Frequency of incidence	Scale of intervention
1	Land Value Tax	Annual rates based on gain inland value uniformly	Area-Based
2	Fees for changing land use (agriculture to non-agriculture)	One time at the time of giving permission for change of land use.	Area/Project based
3	Betterment levy	One time while applying for project development rights	Area/Project based
4	Development Charges (Impact Fee)	One time	Area-Based
5	Transfer of Development Rights	Transaction-based	Area/Project based
6	Premium on relaxation of rules or additional FSI	One time	Area (Road, Railways)/Project (Metro)
7	Vacant Land tax	Recurring	Area-Based

S.No	Value Capture Method	Frequency of incidence	Scale of intervention
8	Tax increament financing	Recurring & for a fixed period	Area-Based
9	Land Acquisition and Development	One time upfront before project initiation	Area/Project based
10	Land pooling system	One time upfront before project initiation	Area/Project based

16.8.4 Way Forward

To go beyond the incremental approach of taking small steps towards urban development, Ministry of Urban Development, GoI has shifted focus to incentivizing Transformational Reform Agenda in urban governance, planning and finance. This 5-point Reform Agenda was discussed with states on the side-lines of launch of VCF Policy Framework. Value Capture Financing is one of the reforms under agenda; others being Moving to a Trust and Verify Approach, Formulating Land Titling Laws, Credit Rating of Urban Local Bodies and Improving Professionalism of ULBs.

The proposed implementation framework specifically with respect to VCF is as below:

Figure 16-4: Proposed Implementation Framework

Further ushering in these transformational reforms, MoUD has decided of integrating VCF into project feasibility assessment for systematic and large scale adoption of capturing a part of potential increase in the value of land and other properties resulting from the proposed investment. VCF tools would be applied for all new projects planned in order to capture the full value being generated to develop infrastructure projects in the area. Consultation will be held with all potential beneficiaries of the project for the value impact assessment in the area of influence and included in the detailed project report (DPR).

VCF is a driver for new opportunities. It is a way to optimize local authorities' resources management by creating a new kind of innovative PPP models. It can be precisely used as a tool to capture the positive externalities in order to finance the necessary investments to enhance and sustain urban development.

The Steps required for Project-based VCF policy framework is mentioned in figure 16.5

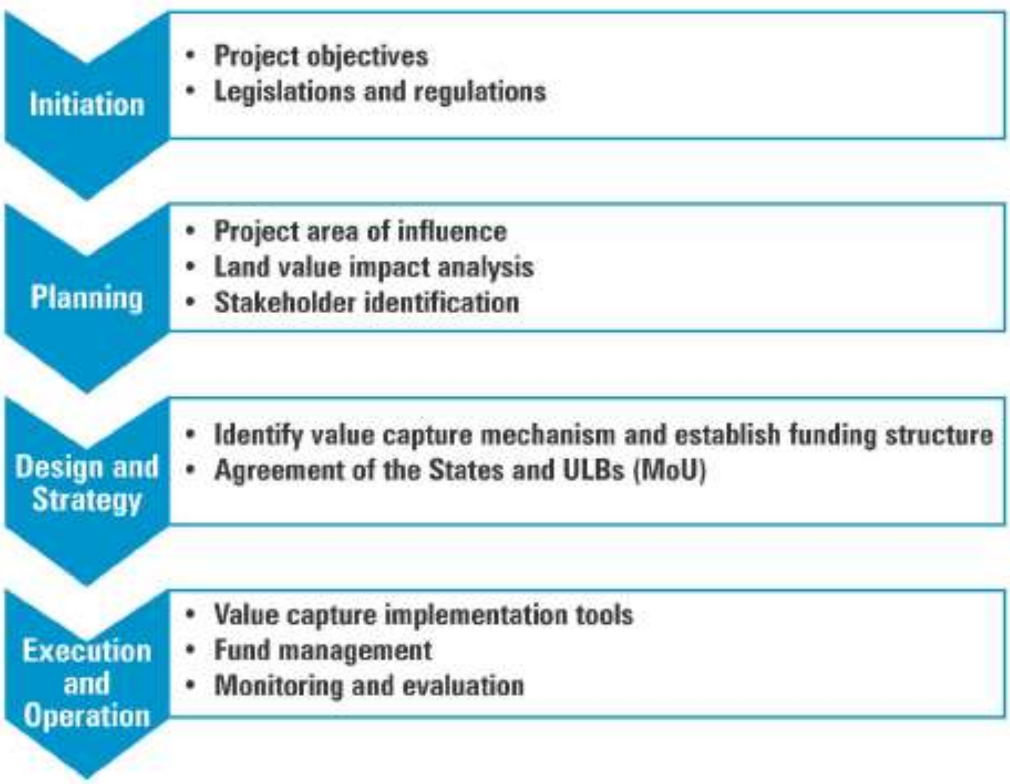


Figure 16-5: Steps required for project based VCF policy framework

The details of different Value Capturing Methods being used by states/ULBs are mentioned in table16.3 for indicative purpose.

Table 16-3: VCF used by various States/UTs

States	Urban Land Tax	Tax on Conversion of Land	Betterment Levy	Development Charge/ Impact fees
Andhra Pradesh	Yes	Section 4 AP Conversion Act 2006	Betterment contribution S. 24 APTP ACT	Development charge - Section 27 APUAD Act
Arunachal Pradesh	No specific provision	Conversion of Agriculture land into Non-agri purpose Rules, 2011; Section 99 (b)(8) AP LSR Act 2000	Improvement Expenses recoverable under section 408-409 APM Act	Section 133 - APM Act, 2007; Section39(1) AP UCP Act 2007

States	Urban Land Tax	Tax on Conversion of Land	Betterment Levy	Development Charge/ Impact fees
Assam	Tax on Specified Lands Section 3 ATSL Act; Assam Land Revenue Reassessment Act 1936	ALRR Act 1936	Section 144 (2)(a) GMC Act; Section 41 ATCP Act; Betterment tax - Section 32-37 Assam Highway Act 1989	No specific provision
Bihar	No specific provision	Bihar Agriculture Land (Conversion for Non-Agriculture Purposes) Act, 2010	Section 131 BMA	Section 60 of Development Charge ; Section 62. Levy of Infrastructure and Amenities Charges under BUPD Act 2012
Goa	Section 109 of City of Panaji Corporation Act, 2002 (both land and buildings are taxed); Section 143 of City of Panaji Corporation Act, 2002 (street tax)	Section 100A of The Goa, Daman and Diu Town and Country Planning Act, 1974 and Rules, 1976; Section 20A of Goa, Daman and Diu Town and Country Planning (Planning and Development Authorities) Rules, 1977	Section 54 of The Goa Housing Board Act and Rules; Section 41 of The Goa Tillari Irrigation Development Corporation Bill, 1999	Sections 43, 100 of The Goa, Daman and Diu Town and Country Planning Act, 1974 and Rules, 1976; Section 20A of Goa, Daman and Diu Town and Country Planning (Planning and Development Authorities) Rules, 1977
Gujarat	Yes	Gujarat Land Revenue (Amendment) Bill-2016	Section 216 of Bombay Provincial Municipal Corporations Act, 1949 (Gujarat Adaptation of Laws (State and Concurrent subjects) Order, 1960.)	GTPUD Act (Chapter VII); value-based development charge also levied;Impact Fees Collected under AUDA
Haryana	No specific provision	Section 3(1) - HDRUA Act	Section 93 - HUDA Act	No specific provision, however, a development charge is collected in controlled area (Haryana Municipal Act section 302D(1))
Himachal Pradesh	No specific provision	No specific provision	No specific provision	Section 61 - HPTCP Act; Development Fee (Section 45) - HPHUDA Act
Karnataka	Yes	Section 18 - KTCP Act and Rates prescribed by Karnataka Planning Authority Rules 1965	Bangalore Development Authority Act 1976	Section 18 A - KTPC Act- for value-based; Area-based also levied
Kerala	No specific provision	Kerala Land Utilisation Order, 1967; The Kerala Conservation of Paddy Land and Wetland Act 2008	Section 25.2.2. of Master Plan for Kozhikode Urban Area-2035; also features in Kerala Irrigation and Water Conservation Act, 2003	Urban Policy and Action Plan for Kerala; Section 20 of The Kerala Building Tax Act, 1975 (referred to as building tax)
Madhya Pradesh	No specific provision	No specific provision	Betterment tax S. 127 (5) (h) MPMC Act; Madhya Pradesh Town Improvement Trust Act 1960; Madhya Pradesh Town and Country Planning Act 1973	Madhya Pradesh Nagar Tatha Gram Nivesh Niyam 1975 and Madhya Pradesh Bhumi Vikas Rules 1985
Maharashtra	Maharashtra Land Revenue Code 1966	Yes	Nagpur Improvement Trust Act 1936 Mumbai Municipal Corporation Act 1888; Mumbai Metropolitan Regional Development Authority (MMRDA) Act, 1974 - Section 26-30	Development Charge Section 124A Maharashtra Regional and Town Planning Act 1961 - Amended in 1993

States	Urban Land Tax	Tax on Conversion of Land	Betterment Levy	Development Charge/ Impact fees
Meghalaya	No specific provision	No specific provision	Section 68 of Meghalaya Municipal Act, 1973	No specific provision
Mizoram	No specific provision	Section 20 of Mizoram Land Revenue Rules, 2013	Section 32 of Mizoram Highways Act, 2002	Section 45 of The Mizoram Urban and Regional Development Act, 1990; Impact fees collected under Section 341 of Mizoram Municipalities Amendment Act 2015
Nagaland	No specific provision	No specific provision	Section 41 of The Nagaland Highways Act, 1967	Section 169 of The Nagaland Municipal Act, 2001
Odisha	No specific provision	No specific provision	Section 677 of Odisha Municipal Corporation Act, 2003; Section 70 The Orissa Town Planning & Improvement Trust Act, 1956; CDP Land and Implementation Policy,2015.	Section 196 of Odisha Municipal Corporation Act, 2003; Section 84 of The Orissa Development Authorities Act, 1982
Punjab	No specific provision	Section 7. Draft Policy for Housing & Urban Development	Section 141 of Punjab Regional and Town Planning and Development Act 1995.	Section 128 of Punjab Municipal Corporation Act, 1976. Policy for utilization of External Development Charges in the State of Punjab.
Rajasthan	Section 20. Notification-Government of Rajasthan. Local Self Government, Urban Development & Housing Department	Section 90-A of Rajasthan Land Revenue Act, 1956		Section 106 Rajasthan Municipalities Act, 2009
Sikkim	No specific provision	No specific provision	No specific provision	Section 94 of The Sikkim Municipalities Act, 2007
Tamil Nadu	TNULT Act	Yes	Yes	Tamilnadu Town and Country Planning Act 1961 - Section 63B; Impact fees collected
Tripura	No specific provision	Section 39 of the Tripura Town and Country Planning Act, 1975	No specific provision	Section 202 of The Tripura Municipal Act, 1994
Uttar Pradesh	No specific provision	Zamindari Abolition and Land Reforms Act; Consolidation of Holdings Act	Section 35 of Uttar Pradesh Urban Planning and Development Act 1973	Sections 14 and 15 of UPUPD Act 1973
Uttarakhand	No specific provision	Section 38-A of Uttarakhand Urban Country Planning Development Act, 1973	Section 35 of Uttarakhand Urban Country Planning Development Act, 1973	Section 15, Section 38-A of Uttarakhand Urban Country Planning Development Act, 1973
West Bengal	WBULT ACT	Sections 4A, 4B, 4C and 4D of West Bengal Land Reforms Act, 1955	No specific provision	Section 102 of The West Bengal Town and Country (Planning and Development) Act, 1979

Source: Value Capture Finance Policy Framework by Ministry of Urban Development, Govt. of India, Feb 2017

16.9 SYNERGY IN TOD

All the 11 Silverline stations and surroundings have huge potential for hub of activities for both Rail users and related users. The development can occur in 3 parts

i) Urban development in a planned manner and by harmonization.
ii) Value Capture Financing.
iii) Railway related business hubs.

16.10 SMART CITY- THE ART OF LIVING

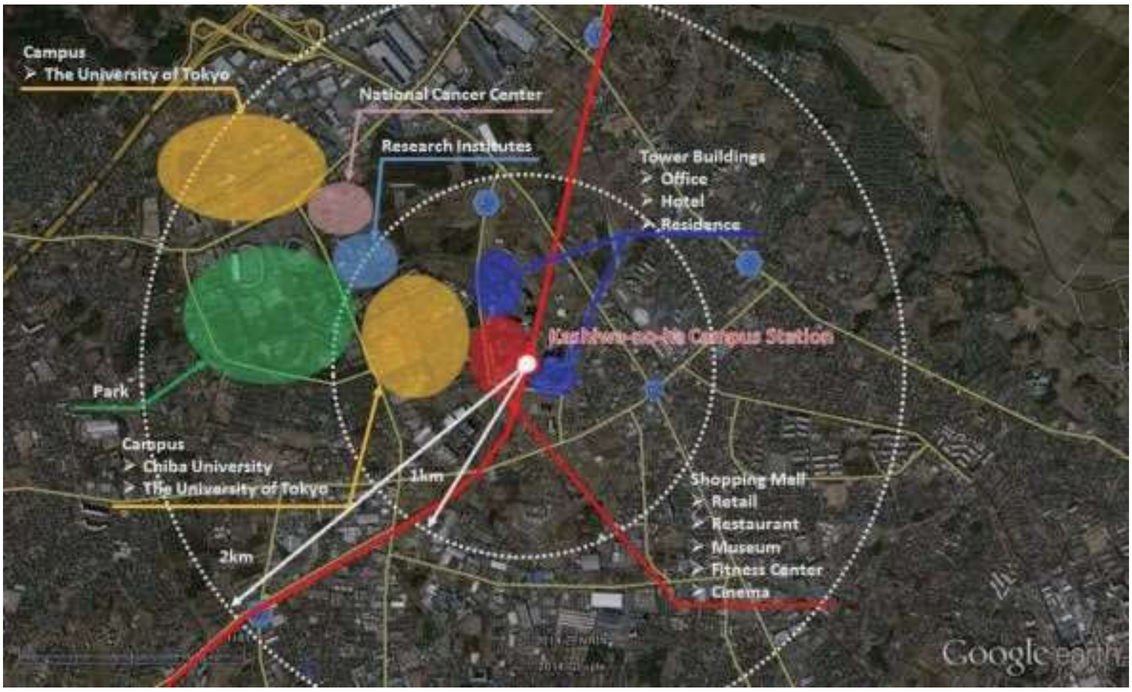
Smart city is a project aimed at efficiency in energy use and reduce carbon footprint by combining Information Technology and Environmental Concepts in a well-defined city where in society of all mixed group of people can live in harmony. SilverLine plays a vital role in developing the smart city concept and make social living enjoyable.

1) **Case Study – Smart City at Kashiwanoha Station (Tsukuba Express), Japan**

Kashiwa-no-ha Smart City is a good case of smart city development mainly conducted by a private developer (Mitsui Fudosan) and associated with other companies at Kashiwa city in Chiba prefecture. Kashiwa-no-ha Smart City is located at 30km from the central part of Tokyo.

Universities, commercial facilities, residential facilities and recreation facilities, etc. are being developed from 2000 around the Kashiwa-no-ha Campus station which is a station on Tsukuba Express Line (TX). These facilities are located within a 2km radius from the station. (Figure 16-6) TX is an intercity train and connects the central part of Tokyo and Tsukuba city.

The themes of the smart city are environmentally friendly, health and longevity and new industry creation. To approach these themes, development of energy efficient building, regionally efficient energy control, urban greening, local community formation, resource circulating system, next generation transport system are being conducted.



Source: Study Team

Figure 16-6: Land Use around Kashiwa-no-ha Campus Station

This is the project by the cooperation with public, private and academia. Though it is on the process of developing, university, research institute, park, office, hotel, residence and shopping mall were assembled in close proximity to each other successfully and it is established as a very convenient area.

2) Case Study: Mumbai Metropolitan Region : Railway Guided Development

Mumbai is the capital of State of Maharashtra in India, and its economy is based on financial services, IT enabled services and media/entertainment. The city of Greater Mumbai is geographically divided into 3 main regions, Mumbai island city (25% of the population (Census, 2011), the Eastern Suburbs (30% of the population (Census, 2011) and the Western Suburbs (44% of the population (Census, 2011). This diffusion of population is correlated with the transformation of Mumbai from a predominantly mono-centric city to a poly-centric city with new business centers in the suburbs. The city credits its rail network, which carries over 7.5 million passengers daily (MCGM, 2005), for enabling this diffusion.

Figure 16-7: Mumbai Sub-Urban Rail Network

The Mumbai Metropolitan Region as of today is spread over 4355 sq.km with 8 municipal corporations, including Greater Mumbai, Thane, Kalyan-Dombivali, Ulhasnagar, Mira-Bhayandar, Bhiwandi Nizampur, Navi Mumbai and Vasai-Virar, 13 municipal councils and 996 villages. It has a population of over 20.7 million and is one of the most populous metropolitan areas in the world (PIB, 2015). The two big cities of this metropolitan of Mumbai and Navi Mumbai support the densest suburban railway network in this region.

Railway Guided Development

The case of Mumbai Metropolitan Region illustrates that efficient urban transport systems are critical elements of the sustainable urban development. An incredible

88% of all travel in Greater Mumbai is by bus and rail; this illustrates the popularity and necessity of having an effective and efficient public transport system, particularly the railways (Sehgal & Surayya, 2011). Suburban rail system is the primary commuting mode in Mumbai metropolitan region, with over 52% of the total daily trips to work made by this mode of transport. Railways in Mumbai Metropolitan Region perform the dual function of connecting the multiple CBDs in Mumbai city and extending connectivity to the suburbs. The high average trip length of 24 km (LEA Associates, 2008) for this mode indicates the regional connectivity provided by the network. Railway has guided and continues to guide the growth of Mumbai in several ways:

• **City form:** The key driver of Mumbai's compactness is its physical geography (Rode, 2007). The linear form of Mumbai city was lent to the railway corridors and growth is seen around the station nodes on all the three main lines. TOD principles suggest intensification activities around transit stations; in case of Mumbai, this began organically.

Figure 16-8: Mumbai Sub-Urban Local Trains (Indicative purpose)

• **Affordable Housing**: Firstly, the high cost of housing in Greater Mumbai invariably forces people, mostly the middle income population who can afford it, to move to distant suburbs in the north and east. The suburban rail network offers a feasible option for their work commute needs. Secondly, the urban poor, who cannot afford the

suburban housing end up squatting on the derelict land along railway lines, along canals and under bridges. The slums are in the city core (eg Dharavi, Mankhurd) because of proximity to eastern and western suburban lines and new slums have now proliferated on the urban fringes along the railway lines (eg. Mankhurd). In Mumbai, access dictates location, proximity and daily routines more than in most other cities, particularly for the urban poor (Rode, 2007) and the middle income group.

• **Affordable transport:** The average monthly expenses (Rs. 400) for suburban rail commuting are the second lowest (just higher than company bus) amongst all modes available in Metropolitan Mumbai (LEA Associates, 2008). This indicates the affordability of railways for majority of households, with median household income of Rs. 7000 in Mumbai.

• **Multiple CBDs:** Mumbai was predominantly a monocentric city, with a tidal pattern of commuting with a directional ratio as high as 80: 20 southbound in the mornings and reverse in the evenings (Balakrishnan). But, the city has now turned poly-centric with new business centers in suburbs such as Bandra-Kurla (diamond bourses and government jobs), Lower Parel (finance, insurance, television and print media), Andheri-Kurla (hospitality, airport), SEEPZ (electronics manufacture and export, IT and BPO) Malad (film production and media houses) and Goregaon (film production), coordinated under the strong railways network.

• **Station and station area planning:** Station areas in Greater Mumbai, like all older cities in India, are predominantly occupied by street vendors, parking for auto-rickshaw, drop off, parking for two wheelers and bus stops for feeder modes such as buses. In a study on Ghatkopar station precinct , EMBARQ found that on an average, 50% people walk or use NMT, 15% use IPT and 34% use buses to reach the station (EMBARQ India, 2014). Also, 12% land is under commercial use and over 29% of the land-use is under mixed use, inviting higher footfall. These figures are representative of most station areas in Mumbai. To alleviate the issues arising from unplanned commercial use and conflict for road space, the Municipal Corporation of Greater Mumbai (MCGM) developed a Station Area Traffic Improvement Schemes (SATIS), whereby skywalks, foot over bridges, separate parking areas for auto-rickshaws and taxis were built at four crowded suburban railway stations. In Navi Mumbai, where stations and station areas were planned and implemented much later, the stations were scientifically designed for quick discharge of passengers that improve the experience of commuters. The station buildings are designed to leverage the commercial space above, and also provide adequate parking facilities, which invites more activities to the station than only commute needs.

• **Feeder systems and last mile connectivity:** Intermodal connections with feeder buses and rickshaws for last mile connectivity are integrated into the development and design of stations. Close to 50% of the operational routes of the biggest bus operator in Mumbai, Bombay Electric Supply and Transport (BEST), pertain to the feeder routes providing last mile connectivity between the suburban rail network and the residential

and office areas (Vasudevan & Mulukutla, 2014). Nearly 34% of the trips to Ghatkopar railway station are on BEST buses (EMBARQ India, 2014).

• **Other transport modes:** Given that the median walking time for household in Greater Mumbai to the nearest bus stop is 5 minutes as compared to between 10-20 minutes to the nearest suburban train station (Baker, Basu, Crooper, Lall, & Takeuchi, 2005), the bus network acts not only as feeders, but also as a primary mode of commute. Buses carry volumes (4,000,000 passengers in Greater Mumbai (Vasudevan & Mulukutla, 2014)) similar to the suburban rail network in the city. Other mass transit modes in Greater Mumbai include metro and monorail. One metro corridor with a current average weekday ridership of 263,000 is complete (out of the nine corridors proposed). A 20 km monorail corridor is also planned in Greater Mumbai for connecting the other island nodes (other than railway inter-changes) with eastern suburbs. These additional corridor aim to fill in the transportation linkage gaps that exist in the east-west direction of the metro region to reduce redundant travel in the north south direction for accessing interchange terminals, in the case of Navi Mumbai as well, other modes share commuters. City's Buses carry 150,000 passengers daily on an average. Navi Mumbai is also in the implementation phase of its own metro network with four corridors. The city is also expanding the suburban railway system with three new suburban rail corridors and doubling the capacity of an existing corridor.

Suburban railway system played significant role in the growth pattern of Mumbai Metropolitan Region. The heavy demand on the system has prompted the planning authorities and the Railways of the region to invest in continuous upgrades and augmentation to the system. Mumbai Metropolitan Region Development Authority (MMRDA), the regional development authority, formulated the Mumbai Urban Transport Project (MUTP) to guide the development of transportation infrastructure in Mumbai Metropolitan Region. The Mumbai Development Plan 2014-34 proposed to tap into the influence of the rail network further and to adopt TOD principles for the development of all station areas on the three suburban lines, metro and monorail corridors in the city of Greater Mumbai (UDRI, 2015). The stations are classified into 3 categories (Order 1, 2 and 3) and varying influence areas respectively (1000m, 500m and 300m) for intense development and value capture of the transit networks. The classification is based on the number of the passenger boarding and alighting at the stations and possible interchange connections with other transit modes. The station areas are to be developed as mixed commercial-residential zones to decrease the need for commuting and encourage walk and bike trips. (Shah, et al., 2014).

Lessons Learnt:

The cities of Mumbai and Navi Mumbai along with the rest of the Mumbai Metropolitan Region typify regional transit oriented development ever since the first railway line. The total passenger traffic growth in this suburban rail network has grown 6 times

since its early beginnings; but the capacity augmentation has been slow (2.3 times). Some important lessons to be learned from the rail story of Mumbai are:

• More than 50% of trips to work in Mumbai are made by walk alone. Such high shares of pedestrian volumes can be retained only with suitable parking reforms that reduce off-street parking minimums to zero near nodes on the suburban network and impose parking maximums, and thereby provide safe and connected walking environment.

• Mumbai's existing densities are high enough to offer financial sustainability to public transportation investments. Within the existing nodes, the focus is on the "shift and improve" mechanisms by improving public transportation operations. It is currently pursued by prioritizing allocation for public transport, NMT and pedestrian facilities, and supporting usage of roadways for public transport (buses) through signal prioritization, roadway allocation etc.

• Affordable housing stock is being built in the northern suburbs and satellite towns of Mumbai (Kalyan-Dombivali, Thane) resulting in longer commutes.

Mumbai Development Plan 2014-2034 proposed to increase FAR in the city; but without rationalizing the values to the existing densities and provision of urban amenities. TOD presents opportunity in the city to develop the low density newer nodes on the global TOD norms of density and diversity while also managing people densities in the highly dense older nodes without worsening the urban experience.

• Housing and transportation are bundled goods in an economic sense that have to be matched with the demand in the market. 130 thousand luxury tenements lie vacant in Mumbai (Frank Knight Real Estate Research Report) while 1.1 million affordable housing units are required in Mumbai (MCGM, 2014). The oversupply of type of houses that do not match the demand indicate the need to rethink the housing strategy for Mumbai. If densification is the objective through a TOD policy, then the rationale for limiting the tenement sizes and retaining some component for affordable and rental housing is unavoidable in TOD projects. TOD enablers such as overlay zones will grant provisions for modifications to DCRs to allow separate provisions/norms for affordable housing in Mumbai.

Stations around the suburban, metro and monorail corridors in Mumbai suffer from lack of proper design of streets and sidewalks infrastructure, competing demands by pedestrians, street vendors and intermediate personal transport (IPT), lack of information about feeder systems and lack of street furniture and other public amenities; factors that greatly influence the attractiveness of walking to the transit stations (EMBARQ India, 2014). Attempts to implement SATIS in Mumbai did not achieve the intended outcomes of facilitating pedestrian movements through the construction of elevated pedestrian walkways. The Mumbai Development Plan 2014-34 now makes the intent to prioritise pedestrian movement at grade, through segregated, comfortable, car-free zones in the immediate vicinity of the transit or intended TOD stations clear.

The TOD policy has been formulated in the Development Plan, but the specific development control regulations (DCRs) are yet to be framed to address parking, urban form and inclusionary housing needs within the influence zones of these target stations (Shah, et al., 2014). Going forward, pro-active interventions will only retain the high public transit share in the city and region.

16.11 MAJOR DEVELOPMENT SCHEME

16.11.1 Urban Area Redevelopment Project

To improve congested central part of the city with low-rise buildings and generate space for public such as parks, streets and squares, the urban area redevelopment project is used to integrate small parcels of land into larger units and rebuild high-rise communal buildings.

Main features are:

- As the redeveloped building has more floors than the previous one, total floor space will be larger than that of previous one.
- The rights of previous landowners will be replaced by the floor space of the redeveloped building so that they will generally have the same value as the previous building (right floor).
- The remaining floor space of the redeveloped building (reserved floor) will be sold to third parties (X) and the profits from sale will be appropriated to redevelopment project expense.
- As the land of the newly built building will be narrower than the previous one, the rest space will be used for public space (Park, road and street).

Source: MLIT

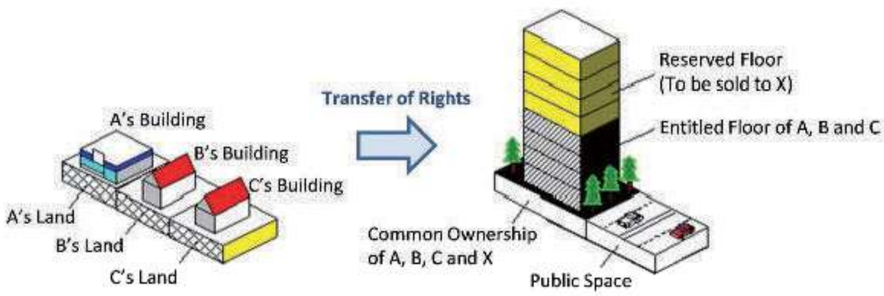
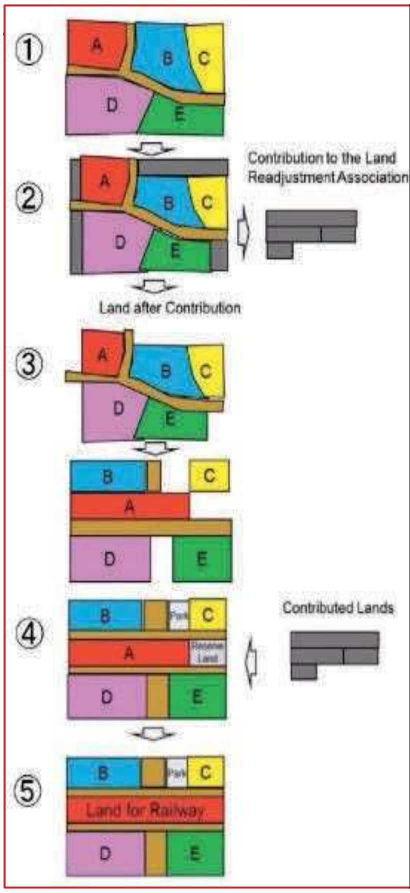


Figure 16-9: Image of Urban Area Redevelopment Project

16.11.2 Land Readjustment Project

Land Readjustment Project is known as a method to increase the value of the land by arranging the shape of the land and create new space for public utility to further improvement in living of people. This method has been widely applied in Japan.

Multiple landowners arrange the land lot by exchanges and generate the land for urban facilities and project expenses by reduction of land space of private owners. If a railway operator participates in the land readjustment project by acquiring the land, the enterprise may acquire the railway land by exchange of land and purchase of reserved land.



Application Flow of Land Readjustment Project

① A railway operator purchases the irregular land lot A and becomes one of the landowners.

② Each landowner contributes part of their land to the land readjustment association (space reduction)

③ Each landowner exchanges the remaining land to make the land lot in regular shape. (land exchange)

④ Reduced land shall be appropriated to the land for urban facilities, including roads and parks, etc. and reserved land.

⑤ A railway operator purchases the reserved land and collects the exchanged land into one place to appropriate railway land.

Features:

- Although the land space decreases from before, as the lot becomes rectangular shape and improvement of roads, etc., which increases the asset value per space and the asset value of the entire land will increase.

16.12 AROUND STATION DEVELOPMENT

There are 11 proposed stations on the Thiruvananthapuram - Kasaragod Semi High Speed Rail Corridor. Of these 11 stations, some of the stations pass through the city or existing CBDs while some are located away from the city centres.

A broad framework was used to identify potential sites suitable for medium to large scale around station development as integrated townships. The two of the three key aspects for the same is availability of the large tract of vacant land as well as location with respect to existing CBD. During study team’s interaction with municipal corporations, it was highlighted that any large development within the city or CBD area will be a herculean task and hence it was recommended that lesser dense or away from CBD area will be preferable for such development which will also help the city to expand.

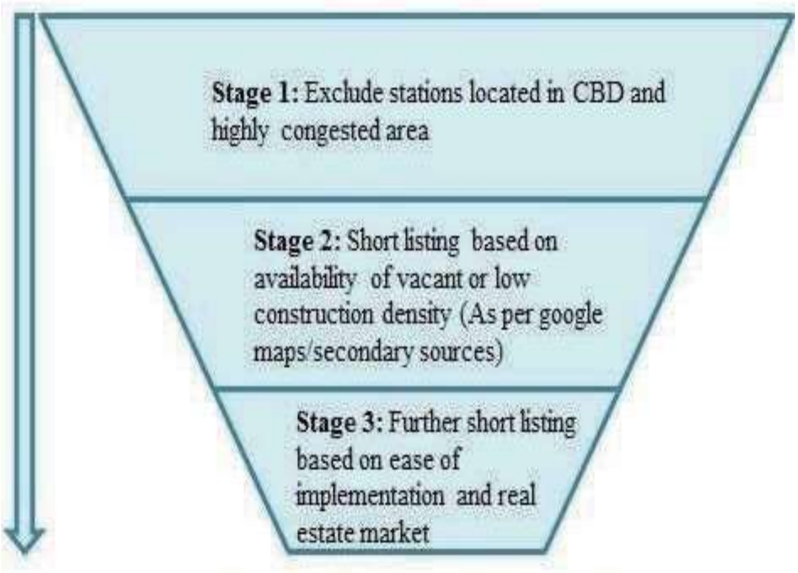


Figure 16-10: Stages

Using these framework and insights from interactions with municipal bodies, the 11 proposed Silverline station locations were mapped based on preliminary available information (and using Google earth images). It shows that,

- Large Greenfield area may be available around proposed Silverline stations at Thiruvananthapuram, Kollam, Ernakulam and Kasaragod.
- Kottayam, Kannur and Thrissur offer medium scale around station development opportunity.
- However, all the land is expected to be privately &/or government owned as these sites are away from existing Indian Railway Network.
- Key aspects which will affect the value capture from around station development.
    - Land ownership & acquisition
    - Development model
    - Share in direct value capture by way of taxes & cess
    - Real estate market (Demand-Supply)

16.12.1 Guiding Principal & Boundary Conditions

A preliminary assessment was carried out for the development around stations. The potential stations has identified as Thiruvananthapuram, Kollam, Kottayam, Ernakulam and Thrissur. The development around station has proposed in two ways, i.e. Property Development within station premises and Commercial property development around the stations in identified land parcels.

Estimation will takes into account the best implementation model guided by the past experiences and interaction with leading developers, i.e. State-initiated development on partnership model.

It is recommended that based on preliminary market survey and identified land parcel, a detailed study to be conducted to plan, estimate cost & revenue, implementation model for identified potential land parcels around station.

16.12.2 Development Model

The three major development models are envisaged for the proposed Silverline Townships or Around Station Business Development as follows:

1) Model-1: Area Development Authority led business model
    - Model-1a: K-Rail as a development authority for the notified area around stations
    - Model-1b: State Government (or state agency) as a development authority for the notified area around stations
2) Model-2: Monetization of railway's surplus land assets located at prime locations
3) Model-3: Transferrable Development Rights

Each of the above models once implemented will contribute for enhancing the non-fare box revenues.

16.12.2.1 Model-1: Area Development Authority led business Model

This is the typical model used across the world, wherein a transit agency or other government agency undertakes the township development. In India, very few success stories (for instance, DMRC) can be found in case of transit agency (completely owned by the central government) acting as a development authority. This is primarily due to lack of state government involvement as a critical stakeholder.

Given the complexity of real estate development, state authorities may be better positioned to act as development authorities.

Table 16-4: Comparison of the Cases

	Model-1a **(K-Rail as authority)**	**Model-1b** **(State Government Agency as authority)**
Land Acquisition aspects	• Land for Silverline (around station development) would be under purview of SPVs of K-Rail. • In any case notification and acquisition of land would need to be done by state agencies and then mechanism of transfer of land to K-Rail would need to be developed.	• Land and real estate is a state subject. • State has powers to notify/de-notify land title, land use, etc. or use land pooling effectively. • State/Government agency handling land acquisition aspects would comparatively smoothen the procedural processes.
Legal & Regulatory aspects	• For land use changes, FSI, etc. and related aspects K-Rail will need to coordinate with state & city governments.	• State agency undertaking real estate/town development falls directly under UDD's purview and coordination is very effective.
Operational aspects	• Integration of proposed developments functions utilities, connectivity with state/city supply involves coordination with various state/city level agencies.	• State agency undertaking real estate/town development falls directly under UDD's purview and coordination is very effective.
Overall impact for K-Rail	• If land is not allotted at free of cost, it will add to overall project cost. • Also, additional capex will be required to undertake real estate development. • High level of coordination for approvals & clearances needed between state, city & central governments.	• Easier to implement, as all approvals & clearances typically lie with UDD or UDD appointed authority. • However, revenue sharing mechanism between the state govt. & K-Rail would need to be decided.

1) Commercial Structure between the Authority and the Developer

Three broad commercial structures can be explored considering the implementation of the project as described in the following Table 16.5.

Table 16-5: Comparison of Structure

For Authority	Self-Development	Joint Development (Partnership Model)	Third party development
Preferred revenue model	Project cash flows	Revenue share	Upfront lease payment
Pros	• Can expect high return - increased cash flows. • Opportunity to capture land value appreciation.	• Shares market risk with the developer. • Access to private sector flexibility, skills & resources (financial & human). • Limited or no capex commitment from Agency. • High returns but lower than self-development option.	• No capex /investments. • Complete market risk with the developer. • Access to private sector flexibility, skills & resources (financial & human). • Upfront &/or certain annuity cash flow stream.
Cons	• Agency incurs high capex. • Entire market risk lies with the agency.	• Most developers prefer revenue share model, which necessitates the need to monitor / keep a check on the commercial aspect of operations.	• Low return/value realization. • Lesser interest among market players for large area on upfront model.
Illustration	• E.g. CIDCO – Vashi & Belapur above & around station development.	• E.g. GIFT City – 50:50 JV between GUDC (Gujarat Urban Development Corporation) and IL&FS.	• E.g. RLDA model, CIDCO - L&T Seawoods, DMRC.

Real estate experts and developers during interaction revealed that

- It is much better if state leads the development initiative, mainly due to
    - Real estate/township is a state subject
    - There is an established trust factor between state/local government and private sector
    - And capability of railways in such a specialized sector given their past experience
- Also, the private sector is wary of large-scale development on upfront payment structure, as it can be seen very few deals are taking place between government and private sectors on upfront payment basis.
    - Joint development structure is the preferred model on revenue share basis with empowered decision-making body/panel to fast track any decisions.
    - Ensure state/local government commitment and interest in the project for a longer tenor.
    - Easier decision making and implementation of the business plan.

Hence, the around station business development has been assumed as

- State-led area development authority (with financing arrangement between the authority and K-Rail).
- Joint development model with revenue share structure.

16.12.2.2 Model -2: Standalone Land Parcels for Monetization

Indian Railway is one the largest landowner in India. Not all of these land parcels are in operational use. Some of the land parcels are vacant or surplus which can be monetized to enhance revenues. Rail Land Development Authority (RLDA) has been formed to monetize such land parcels.

Real estate monetization or bundling with project is being practiced in a large-scale transport project. For instance,

- DMRC Case
    - 5% of the Delhi Metro phase-1 funding was proposed to be achieved from property development. DMRC was allocated land parcels (stand alone as well as linked to metro stations/corridor) for monetization.
        - ✓ Till date, DMRC has leased five large plots (total area – 128,425 m^2) for residential purpose generating an upfront receipt of Rs 5,878 million
        - ✓ Also, it has leased area of around 357,982 m^2 for various commercial purposes on upfront and/or annuity model.

- Other Cases
  - Around 1.67 km^2 of real estate has been bundled with Hyderabad Metro.
  - MOR has proposed real estate bundling with the Churchgate Virar Elevated Corridor.

Similarly, it is proposed that

- In case MOR entrust some of the prime land plots in cities like Kozhikode to K-Rail (similar to the case of Delhi Metro).
- K-Rail can then these land plots on long lease tenor of 80 to 99 years.1) Potential Estimation

The assessment was made based on preliminary research for railway land parcels in Kerala; however, one needs to be cognizant of related issues, such as

- Railway land plots in the city are typically of longitudinal shape with highly skewed length to breadth ratio.
- Connectivity, access to property owing to congestion, encroachment are other key aspects that can cause delays in monetization of the assets.
- Many of the identified land parcels for commercial development are earmarked for some purpose.
- Also, strong coordination will be required with the state & city governments for land use change & FSI approvals.
- Many of the railway land parcels are classified as “Operational Use”, which needs to be changed in order to have commercial development.

Preliminary study shows that substantial area of railway land at Kozhikode can be commercially exploited. However, proper shortlisting of land plots need to be done to bundle some of these plots with Silverline project. One such shortlisting criteria is illustrated below:

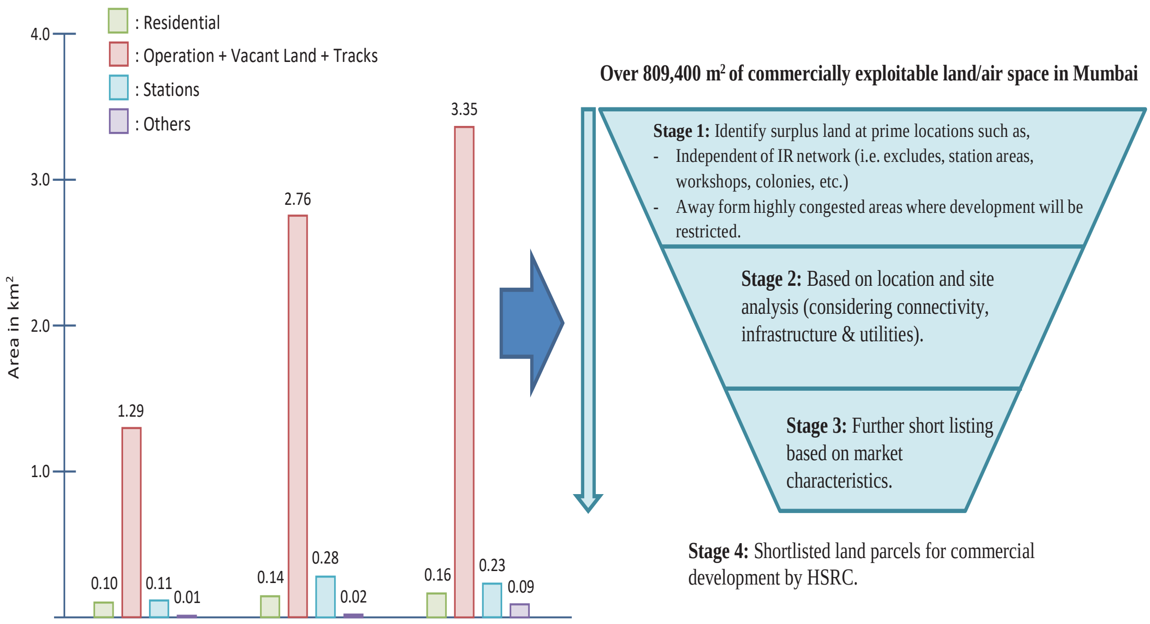


Figure 16-11: Railway Assets in MMR (Left) and Identification of Exploitable Land

The sites identified offers development potential for mixed use or residential use.

Table 16-6: Identified Land Parcels in Kerala

Sr. No.	Land Parcels	Area (Ha)
1	Thiruvananthapuram	25.32
2	Kollam	195.32
3	Kottayam	240.49
4	Ernakulam	222.03
5	Thrissur	20.95

16.12.2.3 Model -3: Transferrable Development Rights (TDRs)

TDR is one of the instruments to capture real estate potential. It can be used to generate revenues from non-viable land/station area development by selling of TDRs in the market. However, support of local and state government will be required to enable market for TDRs function in favour of transit agencies like K-Rail.

1) Key Required Enablers for TDRs

- City to freeze its FSI limits & create market for TDR
  - For instance, as in Mumbai
    - FSI of 2.0 can be split as 1.33 FSI + 0.67 TDR
    - Thus creating a demand side for TDR market
- City should amend DCR laws to enable
  - Market demand for TDR
  - Supply side for TDR by way of granting TDRs to K-Rail
  - Incentives to use TDRs from K-Rail (such as lower premium on use of TDRs procured from K-Rail)
  - Flexibility on supply side

2) **Commercial Model**

- Premium FSI seeker to approach K-Rail to purchase TDRs
- Sale at market rates
- Net proceeds of sale after meeting any agreed share towards cost of civic amenities shared with ULB/SPA
- Case Example – Pimpri – Chinchwad Municipal Corporation (PCMC), Maharashtra, India

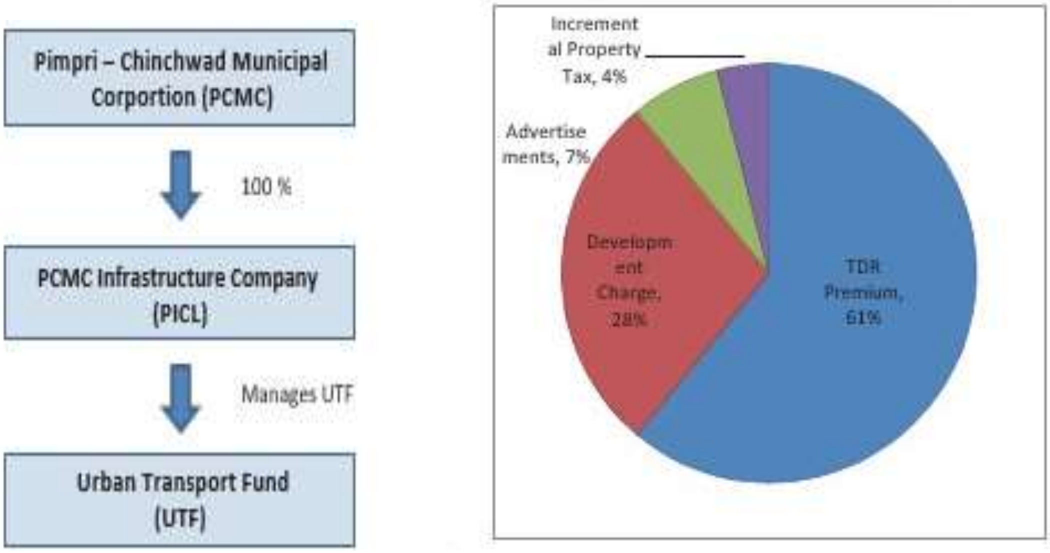


Figure 16-12: Organization Structure and Funding Share of PCMC

- PCMC is developing 130km of Bus Rapid Transit Corridors.
- Created an Urban Transport Fund (UTF) to fund the project.
- Designated 100m on either side of BRT corridor in BRT influence zone.

TDR as a major source of revenue for UTF

- Increased ceiling FSI from 1 to 1.80 in the BRT influence zone, with incremental 0.80 FSI loading TDR with payment of a premium.
- Estimated Potential

- Demand for TDR – ~ 2.1 km^2
- TDR Premium - ~ Rs 17 ~ 18 bn

Advantages:

- Does not release additional FSI in the city, only realigns the FSI from other zones to BRT corridor.
- Will protect the value of TDR and make it more attractive.
- Help PCMC facilities focused service provision by densification.
- Ensure the attractiveness of mass transit and protection to environment.

Similar influence zones can be created across the station areas of HSR. These could be typically between 500 m to 1 km area where the major impact of transit-oriented development is expected to happen.

16.13 LAND VALUE CAPTURE FLOW FOR SILVERLINE

Land values and property prices see upside trend as large connectivity projects are implemented. Hence there is need for proper instruments such as tax/cess on property tax, development surcharge or betterment levy, etc. to capture such an upside in value. One of such models for the SilverLine corridor has been schematically shown as follows:

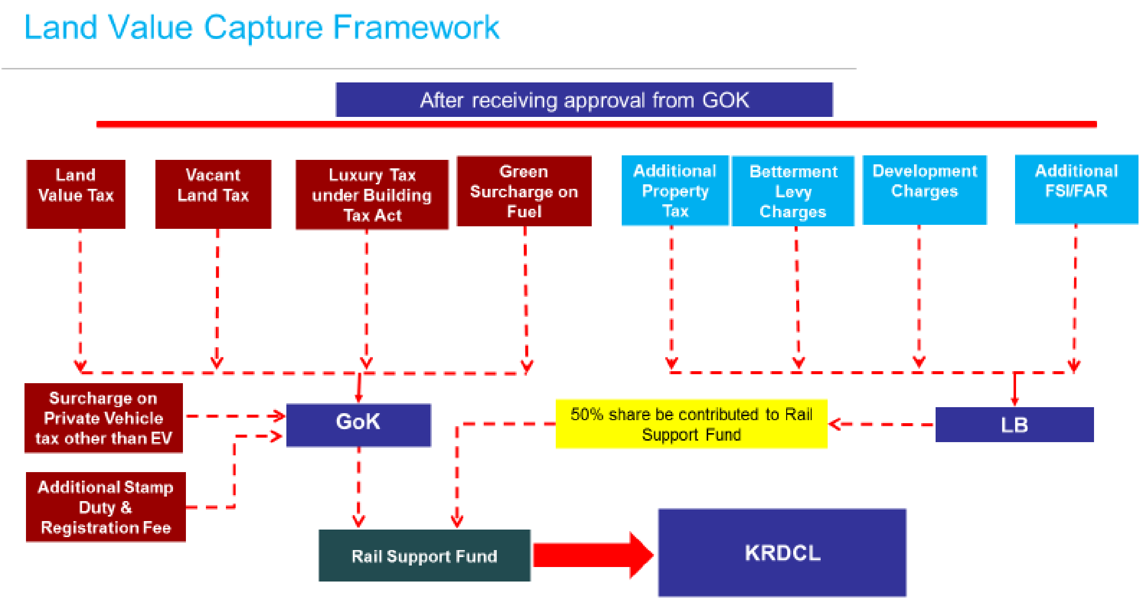


Figure 16-13: Flow of Land Value Capture

As shown in above figure, the flow of value capturing will be routed through local bodies as well as through GoK. The taxes highlighted in red will be administered & collected by GoK and taxes highlighted in blue shall be administered & collected by Local bodies. Then tax revenue collected through GoK & 50% of local bodies will be deposited in Rail Support Fund for further Railway infrastructure developments in the state.

16.14 NON-RAILWAY BUSINESS

The types of non-railway business are categorized into 4 types. These non-railway businesses have been considered and applied by railways in the world.

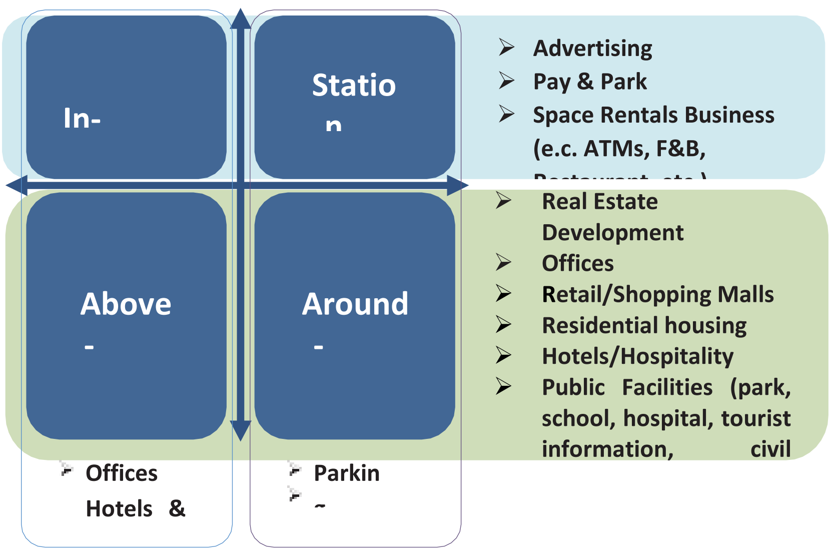


Figure 16-14: Non-Railway Business

16.14.1 Land Development Potential

The SilverLine project will be executed through Special Purpose Vehicles (SPVs) in the form of a subsidiary company of K-Rail as under,

- **(A) RAIL SPV-** To execute the project, operate & maintain the system on behalf of the two Governments (i.e. GoK & GoI) totally independent of Indian Railways.
- **(B) LAND SPS-** for the land bank development beyond the station areas by acquiring land.

The two separate SPVs is necessary for value capturing and to ring fence the risk and avoid risk contamination. The surplus funds generated through the land bank development SPV can be rolled back to the project SPV by K-Rail to improve the cash flow of the Project SPV. While land for the property development rests with rail SPV, land for the area outside the stations will be with land SPV. Rail SPV will entrust the land SPV with the task of commercial development of station area for a fee to be paid to land SPV. Revenue from such commercial development of stations will be with Rail SPV. The Structuring is detailed as below.

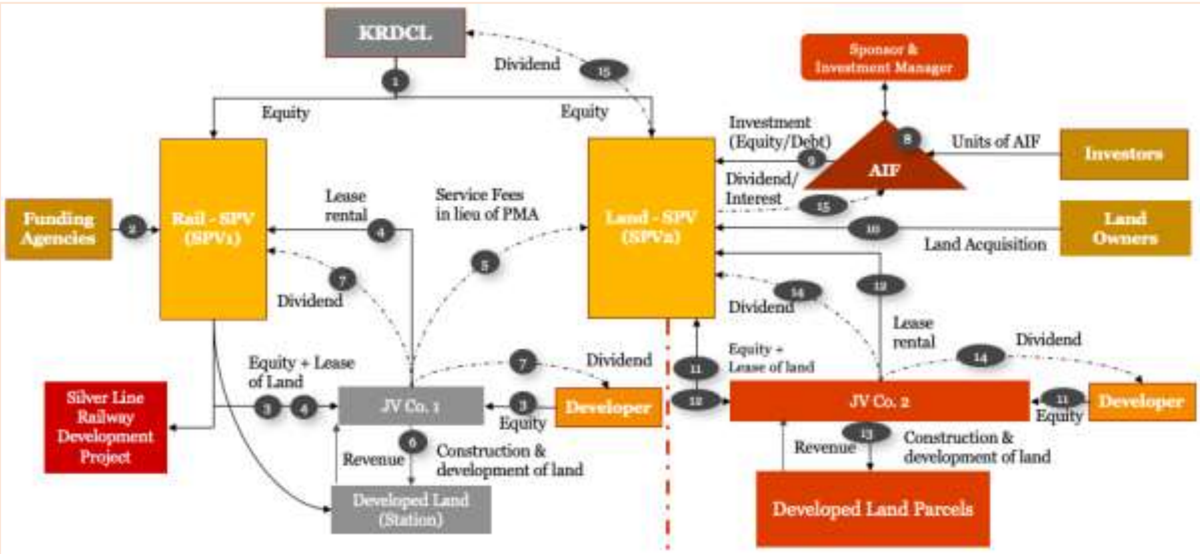


Figure 16-15: The Project Structuring

There are 11 proposed stations on the Thiruvananthapuram-Kasaragod SilverLine Rail corridor. Of these, Property development is possible in all stations except at Kochi Airport station. The table 16.7 gives a glimpse of development potential for above station development in the major urban regions.

Table 16-7: Land Area for Development

Proposed SilverLine Station	Total Area available (Ha)	Area with Rail SPV (Ha)	Potential Area with Land SPV*	Property development Area with Rail SPV(sq.m)
Thiruvananthapuram	42.09	16.77	25.32	258727
Kollam	249	53.67	195.33	256023
Chengannur	42.75	14.18	28.57	121853
Kottayam	256	15.51	240.49	290253
Ernakulam	239	16.97	222.03	260726
Thrissur	57.43	36.48	20.95	311852
Tirur	299.78	9.51	290.27	110452
Kozhikode	19.13	19.13	0	354252
Kannur	18.89	7.17	11.72	252052
Kasaragod	55.86	31.6	24.26	219126

**Potential Area with land SPV is not considered for any financial calculations.*

K-Rail is in the process of appointment of a consultant to help in realizing the above property development opportunities. Scope of the consultant includes the following.

- Site survey and assessment of current and future potential;
- Baselining current data;
- Benchmarking of similar infrastructure nationally and internationally;
- Formulation of Concept Master Plan for each Site;
- Formulation of social and environmental plan;
- Formulation of traffic plan and integration with existing and proposed transport;

- Analysis and recommendations on the locations and design of stations and types of trains;
- Estimation of ROM Costs;
- Preparation of Financial Models; land pooling and land bond options
- Concept Design;
- Project Plan;
- Development and implementation of marketing, branding and positioning strategy;
- Investor outreach
- Formulation of suitable procurement strategy;
- Preparation of procurement documents;
- Assistance in evaluation of Bids and award of concession/contract; and
- Program management and advisory on concessions/contracts and assistance in monetisation.

K-Rail expects to generate around Rs. 7500 Cr to 15000 Cr., from the above land bank development activities through land bank SPV. However this revenue generation has not been considered in financial analysis at present. Potential area that can be developed in stations is estimated as follows. Estimation of potential commercial space at stations with rail SPV is as follows assuming that a private developer will undertake the development on revenue sharing basis.

Table 16-8: Area for proposed Property Development over station

S. No	Station	Total Land area acquired for station (Ha)	Area for Depot (Ha)	Area for RORO (Ha)	Available area for Station (Ha)	FAR	Total Construction Possible (Sq M)	Station Construction Area	Land Area Available for PD (Sq M)	Land Area Available for PD (Sq ft)
1	Thiruvananthapuram	16.77		2.2	14.57	2	291400	32673	258727	27,84,912
2	Kollam	53.68	23.95	1.7	28.03	1	280300	24277	256023	27,55,806
3	Chengannur	14.18			14.18	1	141800	19947	121853	13,11,614
4	Kottayam	15.51			15.51	2	310200	19947	290253	31,24,254
5	Ernakulam	16.97		2.2	14.77	2	295400	34674	260726	28,06,429
6	Thrissur	36.48		2.5	33.98	1	339800	27948	311852	33,56,744
7	Tirur	13.04			13.04	1	130400	19948	110452	11,88,894
8	Kozhikode	19.13			19.13	2	382600	28348	354252	38,13,133
9	Kannur	13.75			13.75	2	275000	22948	252052	27,13,063
10	Kasaragod	46.66	18.78	3.4	24.48	1	244800	25674	219126	23,58,650
		246.17	42.73	12	191.44		2691700	256384	2435316	2,62,13,498

16.14.2 Commercial Model

- **Model-1:** K-Rail develops the above station area and lease out to prospective tenants.
  - For instance, Shri Mata Vaishno Devi Katra railway station where Indian Railways have developed station area with own investments and leased out various spaces. Also the hotel & restaurants are being managed by IRCTC, PSU under Ministry of Railways (MOR).

- **Model-2:** K-Rail develops the above station area and appoints a property management firm on OMT (Operate-Maintain-Transfer) model basis.

- **Model-3:** Public-Private partnership model for station development (main station and above station area) wherein :

- Construction cost of station area will be borne by the private sector.
  - Project SPC mandatory shares revenue with K-Rail after several years of operations (for example, in case of concession tenor of 30 years, K-Rail can contractually mandate revenue share from 15 years onwards).
  - If revenue potential is high, K-Rail can earn upfront premium, while in case low potential, K-Rail can provide Grant/VGF.
- Benefit for the K-Rail will be the minimum fund allocation for the construction of station area, while also realize additional revenues in future.

For the estimation of high-level revenue potential for K-Rail, the following assessment has been carried out assuming model-1 only, given the availability of limited details with respect to model-3. Model-2 is a slight variant of model-1 only but will be useful as HSRC may not readily have the requisite capability.

16.14.3 Proposed Value Capturing Tools for SilverLine

Table 16-9: Proposed Value Capturing Tools for SilverLine

S.No.	Value Capturing Tools	Existing		Proposed as per Kochi Model		Increment
		Applicable Area	Rate (Rs/Ha)	Applicable Area	Rate (Rs/Ha)	
1	Land Value Tax	Panchayat	500	The Influence Area of 1000 m on both sides of SilverLine Stations/TOD land Parcels.	1500	Additional charge of 200% on existing rates.
		Town Panchayat	1000		3000	
		Municipal Corporation	2000		6000	
2	Vacant Land Tax	Nil		The Influence Area of 1000 m on both sides of SilverLine Stations/TOD land Parcels.	1000	
3	Luxury Tax (Property Tax)	**Plinth Area (Sqm)**	**Rate (Rs/Sqm)**	**Plinth Area (Sqm)**	**Rate (Rs/Sqm)**	
		278.9 - 464.5	4000	The Influence Area of 1000 m on both sides of SilverLine Stations/TOD land Parcels.	6000	Additional charge of 50% on existing rates.
		464.5 - 696.75	6000		9000	
		696.75 – 929	8000		12000	
		Above 929	10000		15000	
4	Additional Property Tax	Slab Rates for Residential & Commercial Properties based on area.		The Influence Area of 1000 m on both sides of SilverLine Stations/TOD land Parcels.	Additional charge of 50% on existing rates.	Additional charge of 50% on existing rates.
5	Betterment Levy	Panchayat	7		28	As per SilverLine benefits are
		Municipal Council	10		40	

S.No.	Value Capturing Tools	Existing		Proposed as per Kochi Model		Increment
		Applicable Area	Rate (Rs/Ha)	Applicable Area	Rate (Rs/Ha)	
	(Additional Permit Fee)	Municipal Corporation	15	The Influence Area of 1000 m on both sides of SilverLine Stations/TOD land Parcels.	60	accruing to this areas and resultant better property value the rates may be increased to 400% also.
6	Development Charges	Nil		**Area (Sqf)**	**Rate (Rs/Sqf)**	The Influence Area of 1000 m on both sides of SilverLine Stations/TOD land Parcels.
				3000-5000	100,000	
				>5000	Rs 100,000/- plus Rs 5/- per sqf for the portion above 5000 sqf	
7	Premium on Relaxation of rules or additional FSI/FAR	Max. FAR is 4, For FAR beyond 2.5 upto 4.	Rs 5000	Max. FAR is 4, For FAR beyond 2.5 upto 4.	50% share of FAR premium	The Influence Area of 1000 m on both sides of SilverLine Stations/TOD land Parcels.

<table>
<tr><th rowspan="2">S.No.</th><th rowspan="2">Value Capturing Tools</th><th colspan="2">Existing</th><th colspan="2">Proposed as per Kochi Model</th><th rowspan="2">Increment</th></tr>
<tr><th>Applicable Area</th><th>Rate (Rs/Ha)</th><th>Applicable Area</th><th>Rate (Rs/Ha)</th></tr>
<tr><td></td><td></td><td>NIL</td><td>NIL</td><td>Additional FAR beyond 4 can aslo be permitted.</td><td>Rs 5000 & 100% benefit to SILVERLINE.</td><td>The Influence Area of 1000 m on both sides of SilverLine Stations/TOD land Parcels.</td></tr>
<tr><td rowspan="3">8</td><td rowspan="3">Green Surcharge on Fuel (Applicable area-Kochi Agglomeration)</td><td colspan="2" rowspan="3">NIL</td><td>Commodity</td><td>Rs/Ltr</td><td rowspan="3">Applicable area- Entire Kerala State.</td></tr>
<tr><td>Petrol</td><td>0.25</td></tr>
<tr><td>Diesel</td><td>0.4</td></tr>
<tr><td>9</td><td>Surcharge on Private Vehicle Tax other than EV. (Applicable area-Kochi Agglomeration)</td><td></td><td></td><td>Applicable area- Entire Kerala State.</td><td>10% Green Surcharge on existing Rates</td><td></td></tr>
<tr><td rowspan="2">10</td><td rowspan="2">Additional Stamp Duty and Registration Fee for Property Transaction (Applicable area-Kochi Agglomeration)</td><td>Stamp Duty</td><td>8%</td><td rowspan="2">Applicable area- Entire Kerala State.</td><td colspan="2" rowspan="2">Increase the existing Fair Value closure to Market Value or Double the existing Fair Value and SilverLine share shall be the difference in the Stamp Duty/Registration charges due to change in Fair Value</td></tr>
<tr><td>Registration Fee</td><td>2%</td></tr>
</table>

16.14.4 Estimation of Potential Revenue from Property Development

Based on Table 16-8, the revenue from Property Developments is estimated station wise as shown in Table 16-10. A study on real estate for Kochi, Trivandrum & Thrissur has conducted by M/s JLL in 2018 & according to study the occupancy rate of commercial properties in these cities is 70% to 90%. Based on this study, revenue for 50 years is calculated with occupancy rate of 60% (conservatively) from year of operation & from year 2031, same is 90%. With escalation rate of 3% per annum, revenue of Property development for 50 years is shown in Table 16-11.

Table 16-10: Estimated Revenue from Property Development

Sl No	Station	Area of Construction (Sq ft)	Cost of Construction (Sq ft)	Cost of Construction	Rental Value /sq Ft	Annual Rental (Cr)
1	Thiruvananthapuram	2,784,912	2300	641	45.00	150.39
2	Kollam	2,755,806	1900	524	39.15	129.47
3	Chengannur	1,311,614	1900	249	39.15	61.62
4	Kottayam	3,124,254	1900	594	39.15	146.78
5	Ernakulam	2,806,429	2300	645	65.00	218.90
6	Thrissur	3,356,744	2300	772	43.50	175.22
7	Tirur	1,188,894	1900	226	39.15	55.85
8	Kozhikode	3,813,133	2300	877	39.15	179.14
9	Kannur	2,713,063	1900	515	39.15	127.46
10	Kasargod	2,358,650	1900	448	39.15	110.81
	Total	**26,213,498**		**5,491**		**1,355.64**

Table 16-11: Estimated Potential Revenue (Annuity for SilverLine)

Period		Capital Outlay	Maintenance Expenditure & Fees	Annual Revenue with 100% occupancy	Occupancy	Net Annual Revenue	Cash Flow from Development	Leasing Revenues to SilverLine	Net Cash Flow to Developer
2022	2023	1,647.30	-				(1,647.30)		(1,647.30)
2023	2024	2,882.78	-				(2,882.78)		(2,882.78)
2024	2025	1,210.77	-				(1,210.77)		(1,210.77)
2025	2026		101.67	1,355.64	60%	813.38	711.71	122.01	589.70
2026	2027		115.65	1,423.42	65%	925.22	809.57	138.78	670.79
2027	2028		130.78	1,494.59	70%	1,046.21	915.44	156.93	758.50
2028	2029		147.12	1,569.32	75%	1,176.99	1,029.87	176.55	853.32
2029	2030		164.78	1,647.79	80%	1,318.23	1,153.45	197.73	955.72
2030	2031		183.83	1,730.18	85%	1,470.65	1,286.82	220.60	1,066.22
2031	2032		204.38	1,816.68	90%	1,635.02	1,430.64	245.25	1,185.39

Period		Capital Outlay	Maintenance Expenditure & Fees	Annual Revenue with 100% occupancy	Occupancy	Net Annual Revenue	Cash Flow from Development	Leasing Revenues to SilverLine	Net Cash Flow to Developer
2032	2033		214.60	1,907.52	90%	1,716.77	1,502.17	257.52	1,244.66
2033	2034		225.33	2,002.89	90%	1,802.61	1,577.28	270.39	1,306.89
2034	2035		236.59	2,103.04	90%	1,892.74	1,656.14	283.91	1,372.23
2035	2036		248.42	2,208.19	90%	1,987.37	1,738.95	298.11	1,440.84
2036	2037		260.84	2,318.60	90%	2,086.74	1,825.90	313.01	1,512.89
2037	2038		273.88	2,434.53	90%	2,191.08	1,917.19	328.66	1,588.53
2038	2039		287.58	2,556.26	90%	2,300.63	2,013.05	345.09	1,667.96
2039	2040		301.96	2,684.07	90%	2,415.66	2,113.71	362.35	1,751.36
2040	2041		317.06	2,818.27	90%	2,536.45	2,219.39	380.47	1,838.92
2041	2042		332.91	2,959.19	90%	2,663.27	2,330.36	399.49	1,930.87
2042	2043		349.55	3,107.15	90%	2,796.43	2,446.88	419.46	2,027.41

Period		Capital Outlay	Maintenance Expenditure & Fees	Annual Revenue with 100% occupancy	Occupancy	Net Annual Revenue	Cash Flow from Development	Leasing Revenues to SilverLine	Net Cash Flow to Developer
2043	2044		367.03	3,262.50	90%	2,936.25	2,569.22	440.44	2,128.78
2044	2045		385.38	3,425.63	90%	3,083.07	2,697.68	462.46	2,235.22
2045	2046		404.65	3,596.91	90%	3,237.22	2,832.57	485.58	2,346.98
2046	2047		424.89	3,776.76	90%	3,399.08	2,974.20	509.86	2,464.33
2047	2048		446.13	3,965.59	90%	3,569.03	3,122.91	535.36	2,587.55
2048	2049		468.44	4,163.87	90%	3,747.49	3,279.05	562.12	2,716.93
2049	2050		491.86	4,372.07	90%	3,934.86	3,443.00	590.23	2,852.77
2050	2051		516.45	4,590.67	90%	4,131.60	3,615.15	619.74	2,995.41
2051	2052		542.27	4,820.20	90%	4,338.18	3,795.91	650.73	3,145.18
2052	2053		569.39	5,061.21	90%	4,555.09	3,985.71	683.26	3,302.44
2053	2054		597.86	5,314.28	90%	4,782.85	4,184.99	717.43	3,467.56

Period		Capital Outlay	Maintenance Expenditure & Fees	Annual Revenue with 100% occupancy	Occupancy	Net Annual Revenue	Cash Flow from Development	Leasing Revenues to SilverLine	Net Cash Flow to Developer
2054	2055		627.75	5,579.99	90%	5,021.99	4,394.24	753.30	3,640.94
2055	2056		659.14	5,858.99	90%	5,273.09	4,613.95	790.96	3,822.99
2056	2057		692.09	6,151.94	90%	5,536.74	4,844.65	830.51	4,014.14
2057	2058		726.70	6,459.53	90%	5,813.58	5,086.88	872.04	4,214.85
2058	2059		763.03	6,782.51	90%	6,104.26	5,341.23	915.64	4,425.59
2059	2060		801.18	7,121.64	90%	6,409.47	5,608.29	961.42	4,646.87
2060	2061		841.24	7,477.72	90%	6,729.95	5,888.70	1,009.49	4,879.21
2061	2062		883.31	7,851.61	90%	7,066.44	6,183.14	1,059.97	5,123.17
2062	2063		927.47	8,244.19	90%	7,419.77	6,492.30	1,112.97	5,379.33
2063	2064		973.84	8,656.39	90%	7,790.76	6,816.91	1,168.61	5,648.30
2064	2065		1,022.54	9,089.21	90%	8,180.29	7,157.76	1,227.04	5,930.71

Period		Capital Outlay	Maintenance Expenditure & Fees	Annual Revenue with 100% occupancy	Occupancy	Net Annual Revenue	Cash Flow from Development	Leasing Revenues to SilverLine	Net Cash Flow to Developer
2065	2066		1,073.66	9,543.68	90%	8,589.31	7,515.64	1,288.40	6,227.25
2066	2067		1,127.35	10,020.86	90%	9,018.77	7,891.43	1,352.82	6,538.61
2067	2068		1,183.71	10,521.90	90%	9,469.71	8,286.00	1,420.46	6,865.54
2068	2069		1,242.90	11,048.00	90%	9,943.20	8,700.30	1,491.48	7,208.82
2069	2070		1,305.04	11,600.40	90%	10,440.36	9,135.31	1,566.05	7,569.26
2070	2071		1,370.30	12,180.42	90%	10,962.37	9,592.08	1,644.36	7,947.72
2071	2072		1,438.81	12,789.44	90%	11,510.49	10,071.68	1,726.57	8,345.11
2072	2073		1,510.75	13,428.91	90%	12,086.02	10,575.27	1,812.90	8,762.36
2073	2074		1,586.29	14,100.35	90%	12,690.32	11,104.03	1,903.55	9,200.48
2074	2075		1,665.60	14,805.37	90%	13,324.84	11,659.23	1,998.73	9,660.51

16.14.5 ESTIMATED REVENUE GENERATION

It is assumed that towards completion of construction of SilverLine project, the velocity of transaction would increase from 5% to 10%.

Table 16-12 gives the estimated revenue from VCF and the total amount of fund generated up till FY 2054 is Rs.550.85 Cr.

Table 16-12: Estimated VCF revenue after Construction

Sr. No.	Year (FY)	Total VCF Revenue (Rs in Cr)
1	2025	269.18
2	2031	312.17
3	2041	399.60
4	2051	511.52
5	2054	550.85

16.15 CHALLENGES AND MITIGATION PLAN FOR IMPLEMENTATION OF TOD

16.15.1 Challenges For Implementation Of TOD

Transit Oriented Development (TOD) complements the concept of new urbanism. Compact, mixed-use communities are the answer to suburban problems. Due to the dynamic nature and multiplicity of underlying features and definitions of TOD, no umbrella strategy works for all cities. Every city is different in nature and has a unique fingerprint, therefore, to make a successful strategy for TOD it is important to list out specific indicators or key components for measuring the TOD scope of a city.

Indian cities are plagued with issues such as rising population and underdeveloped public transport systems, which have led to a rapid rise of personal vehicles, traffic congestion, and increasing pollution. The majority of the population does not use public transport because of the lack of it and inaccessibility to the transit. Hence, planning for accessibility is the need of the hour. The most important reasons for implementing TOD in Indian cities is the emphasis on public transport by all levels of government.

One of the fundamental challenges is that the regulatory framework of most municipalities is not supportive of TOD. Cities have zoning ordinances and land development codes designed for automobile-oriented development. The conditions

regarding physical requirements under the zoning ordinances often prohibit the development necessary for TOD. Provisions such as maximum floor area ratio, height limitations, landscaping requirements and minimum parking requirements often cause an impediment to develop and incorporate TOD seamlessly into the existing regulatory framework of the cities.

16.15.2 Mitigation Strategies For TOD Implementation

(i) To move towards a sustainable and successful TOD environment, the regulatory framework should be reflective of the following principles: **Amendment of local laws and reduction in time gap between notification and successful implementation of the TOD policy at state level:** There should be suitable provisions in place for creation/designation of an agency with single-point responsibility for successful implementation in a timely manner, including notification incorporation of TOD policy into local building bye-laws. Establishment of enforcement mechanisms with penalties/ sanctions for non-compliance and delays.

(ii) Availability of Land and Land Acquisition: As TOD was not a part of city development from its inception stage, suitable parcels of land will need to be acquired to undertake TOD. Land aggregation is a major concern for the TOD policy as undertaking necessary pedestrian-friendly development would require acquisition of land along the right of way of the public transportation system. A possible solution to this challenge is land-pooling which allows land to be aggregated to enable mixed-use development. Formulation of a detailed project report that clearly identifies land parcels that need to be acquired from early stages of project development with specified time line which will aid in the success of TOD.

(iii)Increased flexibility in existing contracts and contractual commitments: The contractual framework for a TOD project needs to tie in seamlessly with the existing contractual framework for transit development projects. In case the existing contractual framework does not permit ‘expansion’ or ‘change in the original scope of work’ of the transit-oriented development, it may lead to delay in implementation of the TOD project. Existing contractual limitations in transit development project will adversely impact the implementation of the TOD project. Suitable provisions should be incorporated to allow flexibility and amendments to existing contracts.

(iv)Price and Quality Regulations in PPPs: Parking needs to be controlled through effective parking management. Amendments must be made to the local parking policies of the cities so as to deter use of private vehicles and encourage public transport as a preferred choice.

(v) Gentrification: There is an increasing demand for housing in neighbourhoods around public transit projects. Average prices for homes near TOD areas may be costlier than in areas far from such developments. This may deter Affordable

Housing. In this context, those with poor purchasing power may get replaced by the richer households through the process of Gentrification. The TOD in the influence zone maybe planned in a manner so as to facilitate Affordable Housing. The allocated minimum percentage for allowed FAR for Affordable Housing as per the present TOD policy maybe revised.

(vi)Giving teeth to the guidelines: Cities have guidelines or advisory documents instead of regulations and policies in many cases. Guidelines are simply recommendations which should be implemented, but they are not mandatory. One of the simplest examples here is the case of street guidelines, which have been developed in many cities across the country (including Delhi and Chennai), yet they carry little weight due to their advisory nature. Area Based Development within a Smart City Proposal or a city's Transit Oriented Development Policy, present an opportunity to turn such advisory documents into regulations and policies. Bhubaneswar has proposed this in its Area Based Development, where it is implementing a complete streets policy to diversify its mode share.

To conclude, it is necessary to adopt the following:

- provision of affordable housing
- provision for variety of housing choices to meet the needs of all sections of society
- progressive and flexible parking policies which deter use of privately owned vehicles and incentivise people to use mass transport
- charging higher market rates for parking
- encouraging walking and cycling through creation of infrastructure that's safe
- mainstreaming TOD as part of statutory/building/city plans and making use of innovative tools and incentives to finance TOD initiatives and projects into the existing policy framework.

There is a need for a robust policy framework governing TOD in India which is applied across national and state levels.

16.16 RECOMMENDATION

16.16.1 Implementation

The SilverLine project will be executed through Special Purpose Vehicles (SPVs). The two separate SPVs is necessary for value capturing and to ring fence the risk and avoid risk contamination. The surplus funds generated through the land bank development SPV can be rolled back to the project SPV by K-Rail to improve the cash flow of the Project SPV. While land for the property development rests with rail SPV, land for the area outside the stations will be with land SPV. Rail SPV will entrust the

land SPV with the task of commercial development of station area for a fee to be paid to land SPV. Revenue from such commercial development of stations will be with Rail SPV.

16.16.2 Connection with Other Transport Modes at SilverLine Station

Good connection with other transport mode is a key factor for SilverLine passenger's convenience.

- The connection with SilverLine and other planned transport modes should be considered especially in Ernakulam, Thrissur, Kozhikode and Kasaragod where there are urban transport systems are under planning and construction. It is recommended to consult with stake holders of each transport project regarding the key factors below:
  - Location of the planned transport facilities
  - Pedestrian walkway
  - Elimination of level difference

16.16.3 City Development along SilverLine Corridor

It is recommended to develop an area around the station by the operator itself or attracting developers or with state related governments because the area in front of the station has huge economic potential.

Also it is recommended that consideration of new land use or creating of new destinations for passengers such as university, amusement park, medical centre, IT parks, tourist destination and residential township around the SilverLine station especially in suburban area such as Kochuveli, Ernakulam, Thrissur and Kozhikode. These destinations can stimulate passengers and increased traffic volume which may cater the economic growth of the areas around the station.

These kinds of new development should be considered by related governments and reflected to the regional development plans.

16.16.4 Value Capture by Station Area Development

There are some ways for K-Rail to capture a benefit from station area development. They are:

(i) **Area development authority led business model:** Which can be comparatively easily applied at Kochuveli, Ernakulam, Thrissur and Kozhikode where there is less land development around the SilverLine station location at the present moment. As estimated in the report, financial contribution of station area development to the SilverLine project can be expected at some extent. Since state govt. or its agency is to be a key player for the project, it is recommended to consult with them to coordinate for the project.

(ii) **Transferrable Development Rights (TDR):** K-Rail generates revenues by selling TDR of non-viable railway land or station area and TDR contributes to concentrate the development activities on around the station. Support of State Govt. is required to enable market for TDR to function in favour of K-Rail.

(iii) **Monetization of Railway's Surplus Land Assets located at Prime Locations:** Some vacant or surplus railway land can be utilized for monetizing. K-Rail is allocated land parcels and sells or leases the land to generate revenues. Some land railway land parcels can be seen especially in Thrissur and Kozhikode.

16.16.5 Others

For the case of the SilverLine stations adjacent to existing railway station, it is recommended to re-build integrated station complex for better convenience for passengers, efficient use of land.

DETAILED PROJECT REPORT

SEMI HIGH SPEED RAIL CORRIDOR
THIRUVANANTHAPURAM TO KASARAGOD

VOLUME II - MAIN REPORT
(PART D)

CHAPTER 17
PROJECT FINANCING OPTIONS

17 FINANCING OPTIONS

17.1 FINANCING OF RAIL INFRASTRUCTURE

The development of transportation systems takes place in a socioeconomic context. Finance can play an important role in the optimal allocation of the resources thereby influencing the economics of the transport and leveraging new investment. Investment may be wholly by public sector or private sector or mix of both.

Rail based regional transit systems are highly capital intensive projects with moderately lower financial rate of return but with higher economic internal rate of return. Given the high scale of investment costs, long gestation period and requirement for continuous operations even during off peak hours, provision of continuous service, it is seen that private sector investment can be a viable option only in highly congested cities and that too with the support of government subsidies. Internationally, provision of public transport services is one of the important functions of the Government with very few examples of it being profitable primarily due to high non fare box revenue. Hong Kong has one of the highest non fare box revenue collections in the world at 37% and yet 66% of the capital contribution comes from the government. This underlines the fact that government funding is required despite exploring non fare box revenue sources as well.

In recent years innovative means of financing have come to play strategic role in optimizing the rail based regional transport. It represents a viable alternative to investments being funded entirely through annual allocations from public budgets. It is an attempt to translate the role of the private sector into one of the partnerships with public sector without compromising with the public service character of the public transport.

17.2 FUNDING OPTIONS

17.2.1 Objectives of Funding

The objective of funding semi high speed rail systems is not necessarily enabling the availability of funds for construction but it is coupled with the financial closure concerns, which are of no less importance in: -

- Ensuring debt funds at low rates of interest
- Creating self-sustainable system in the long run by
  - Low infrastructure maintenance costs
  - Setting fares which minimise dependence on subsidies
  - Improving financial viability of the project and reducing burden on the Governments
- Recovering returns from both direct and indirect beneficiaries

The SilverLine project is expected to be completed in a period of 5 years. Physical work can start only after the project is approved by Government of Kerala and Government of India, debt funding is finalised, the special purpose vehicle (SPV) for implementing the project is set up, consultants are engaged for assisting the SPV, preliminary designs for civil works are all finalised, and substantial part of the private lands are taken possession of.

17.2.2 Alternative Models of Financing

The financing option shall depend upon selection of the dedicated agency created to implement the project which can be classified as: -

Fully/ Partly Government funded models

1. Option 1- Implementation of the entire project through a SPV
2. Option 2- Implementation of the entire project through a SPV with partial external equity

PPP Models

1. Option 3- Build Operate Transfer (BOT) through a PPP model
2. Option 4- Operations & Maintenance and Part funding of construction cost by private sector
3. Option 5- Leasing of Rolling Stock

These models of financing are discussed in detail in the following sections

17.2.2.1 Option 1 - Implementation of the entire project through a SPV

Some of the projects are financially not free-standing therefore government needs to develop them in order to meet the overall objectives of providing connectivity and social commitments. Project Special Purpose Vehicle (SPV) shall be established with equity participation from respective government shareholders for implementation of such projects. Delhi Metro project is implemented under this structure.

In this option, the Project SPV which will be formed between Ministry of Railways and Govt of Kerala shall be responsible for undertaking construction, operations & maintenance of the system. Civil construction works, other functions of system including procurement of rolling stocks, signalling & telecommunication, fare collection system and operations & maintenance shall be the responsibility of the SPV.

Ministry of Railways (Government of India) and Government of Kerala shall together contribute equity funds equivalent up to 40% of the Project Cost (excluding the Cost of Land and taxes) and balance 60% shall be financed through a soft loan from a bilateral/ multilateral funding institutions. Land and State Taxes shall be funded by the State Government and Central taxes by Government of India.

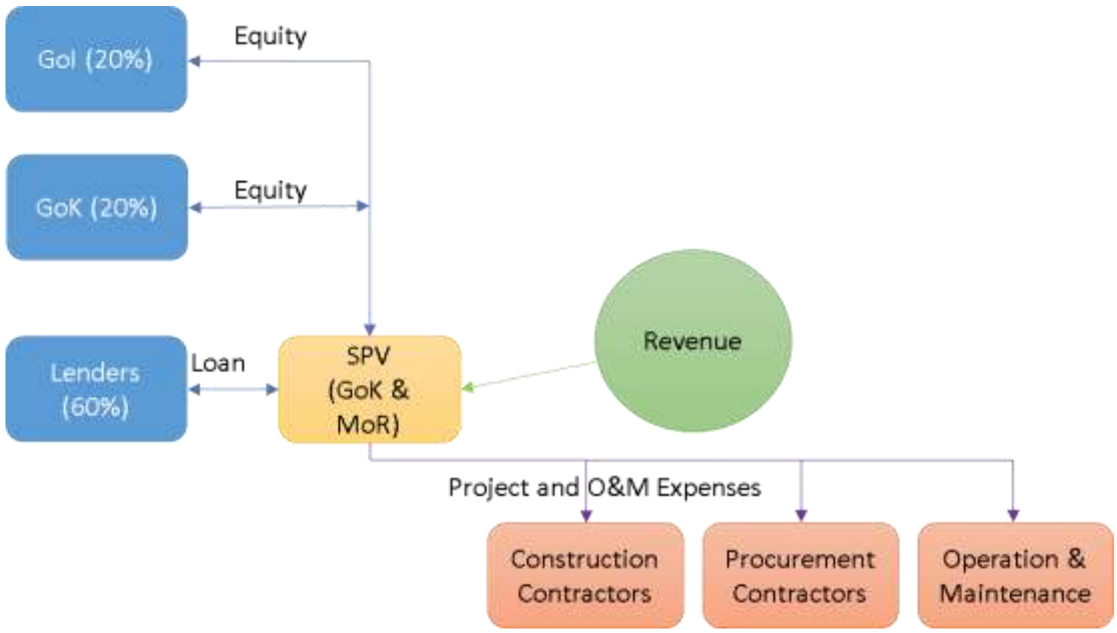


Figure 17-1: Option 1 Finance Model

- **Advantages-**
  - Inherent nature of project requires Government involvement
  - Clear Command and Control with administrative and policy level support
  - Availability of low cost funds from bilateral/ multilateral funding institutions
  - Clearances and approvals
  - Successful projects such as DMRC, BMRC, CMRL, NCRTC etc
- **Disadvantages-**
  - Lack of financial and commercial risk sharing with private sector
  - Constraints on government funds

17.2.2.2 Option 2 - Implementation of entire project through a SPV with partial external equity

It is more or less similar to the Option-1 Finance model. In this scheme the equity is expected from the Public/ other sources in addition to the equity scheme in Option-1. As per this scheme the equity shares of GoI and GoK is proportionally reduced to the extent of public participation as compared to Option-1. The balance fund has to be raised by the SPV from the bilateral/multilateral funding agencies

Kerala has been successful in raising public equity funds in the past for projects like Cochin International Airport Ltd (CIAL) and recently Kannur International Airport Ltd. CIAL has turned into one of the most efficiently run institutions in the state with Government of Kerala holding about 33% shares and remaining shares held by public which include banks, Central Government PSU, State Government PSU, Indian Body Corporates and individuals. Following the footsteps of CIAL, Kannur Airport was also modelled as Public Private Partnership and the Government of Kerala, owns about 33% of the company's shares. Other shareholders of KIAL are State and Central

Public Sector Undertakings, Airports Authority of India, others including QIBs, Individuals, Companies, Cooperative, Banks/Societies and other legal entities as approved by the Board of Directors from time to time. In line with the CIAL and KIAL model, it is expected that SilverLine Project will also be able to raise equity funds up to 40 % of the total equity capital from public/ other sources

This model is also supported by the Joint Venture Agreement between the Ministry of Railways - GOI and Government of Kerala, by means of which the joint venture company undertaking the development of the rail project through a Project SPV. The abstract of the relevant clause of the MOU is given below:

Subject to the consent of the parties, the Project SPVs may on a need basis, and to cater to specific projects, permit equity participation by other shareholders such as banks, public sector undertakings, ports, mines etc. Notwithstanding the foregoing, the equity holding of the JVC in the Project SPVs will at all times, be at least 26% (twenty six percent) of the equity share capital of the Project SPVs.

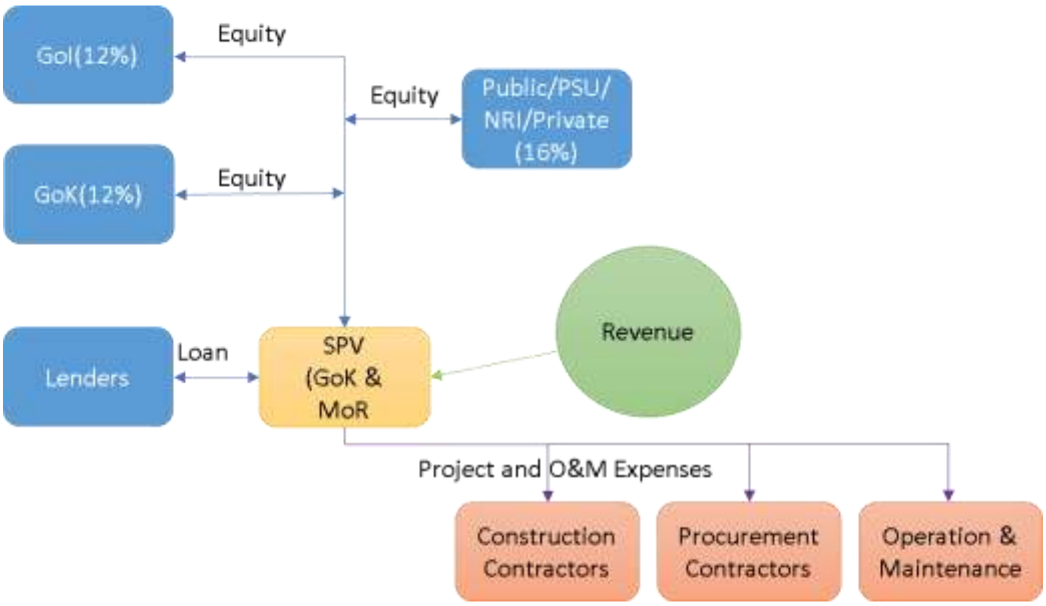


Figure 17-2: Option 2 Finance Model

- **Advantages-**
  - Inherent nature of project requires Government involvement
  - Clear Command and Control with administrative and policy level support
  - Availability of low cost funds may be possible based on negotiations with bilateral / multilateral funding agencies
  - Clearances and approvals
  - Reduced dependence on Governments financial resources as the Equity contribution of GoI and GoK is proportionally reduced
- **Disadvantages-**
  - Lack of financial and commercial risk sharing with private sector

- Constraints on government funds
- Construction activities and project execution by SPV depends on the equity raised from Public participation and delays could affect the project.

17.2.2.3 Option 3 - Build Operate Transfer (BOT) through a PPP model

Public Private Partnership (PPP) arrangements are steadily growing in use particularly in road, power, and telecom sectors which are more of commercial nature rather than in a social sector project. PPP models are arrayed across a spectrum ranging from BOT where the private sectors have total involvement to other tailor made models where both public and private sector assume separate responsibilities.

BOT is the most common form of PPP. It is possible to identify one single private developer who would be responsible for both project implementation phase as well as project operations phase. Therefore, such selected operator shall undertake - detailed engineering activities, plan and construct, raise finances, operate, maintain, manage, collect revenue, repay loan, make additional investments for capacity augmentation and replacement. The single point responsibility is a good PPP structure and also innovation in construction, design and operations can happen.

While a financially free standing project would involve payment to the government, a financially weaker project can be supported by Government through a capital and / or operation grant (VGF) from dedicated Urban Transport Fund / through Planned Budget provision. Government acquires required land for development of SilverLine corridor and hand them over to the private entity for implementation.

The private operator may show interest where the rate of return is in the range of 16% to 18% (Equity IRR).

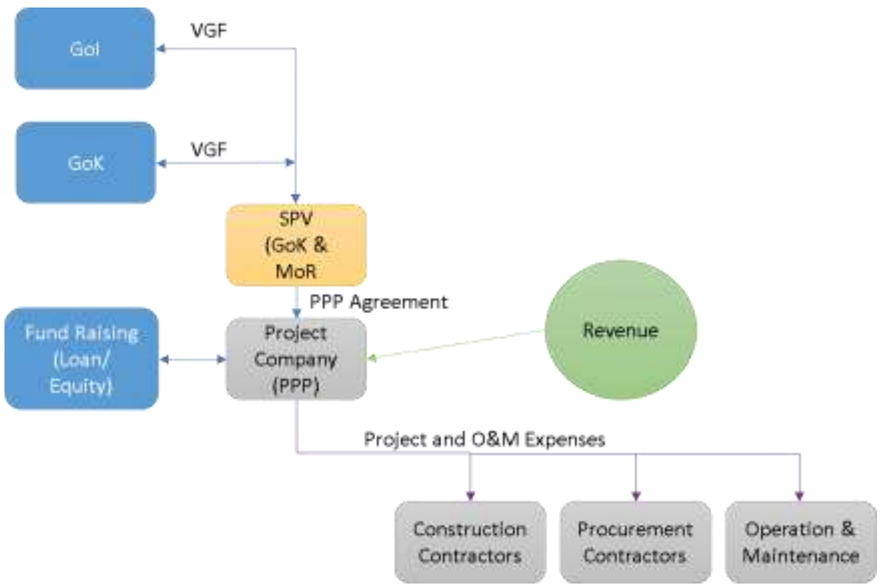


Figure 17-3: Option 3 Finance Model

- **Advantages-**
  - Involvement of private partner during design and construction stage
  - Reduced dependence on Governments financial resources as there is no Equity contribution of GoI and GoK.
  - Project Execution & Operation risks are with private developer and risks of GOI and GOK are mitigated.
- **Disadvantages-**
  - Market may not have sufficient depth to deliver such project
  - Issues with administration, land acquisition etc.
  - Higher Cost of funds to private developer.
  - Funding issues due to inherent project characteristics (capital intensive)
  - Concessionaire may be required to be paid upfront for construction
  - Government to provide the VGF which may be higher in comparison to equity shares in the previous models. (VGF- Up to 20% of the project cost)
  - Private sector expects an Equity IRR of 16-18% for viability.

17.2.2.4 Option 4- O&M and Part funding of construction cost by private sector

In this Option, various combinations of asset ownership options along with operations & maintenance by the private sector can be structured like:

1. Public sector finances both civil infrastructure and procurement, owns all assets and grants a right of utilisation for facilities to Private sector. Private sector takes ridership risk and collects fare from commuters, and O&M expenses will be recovered by farebox revenue. This PPP Net Cost has been applied for Downtown Line, North-East Line, and Circle Line in Singapore. Apart from these Blue Line in Thailand, Delhi Metro Airport Express in India, and North-South and East-West Line***. (JICA, October 2015).***

   Accordingly, the entire project infrastructure would be developed through a Special Purpose Vehicle (SPVs) of the Ministry of Railways and Government of Kerala. After development of the infrastructure, the operations phase is leased out to private sector. This approach could reduce the project cost due to difference in the borrowing cost of SPV vs cost of borrowing by the private sector.
2. Only the rolling stock and Operations & Maintenance are leased to the private sector for an annual fee with all remaining scope handled by the SPV.
3. The scope of procurement of rolling stocks, signalling & communication, ticketing & fare collection system and operation & maintenance could also be undertaken through the private sector.

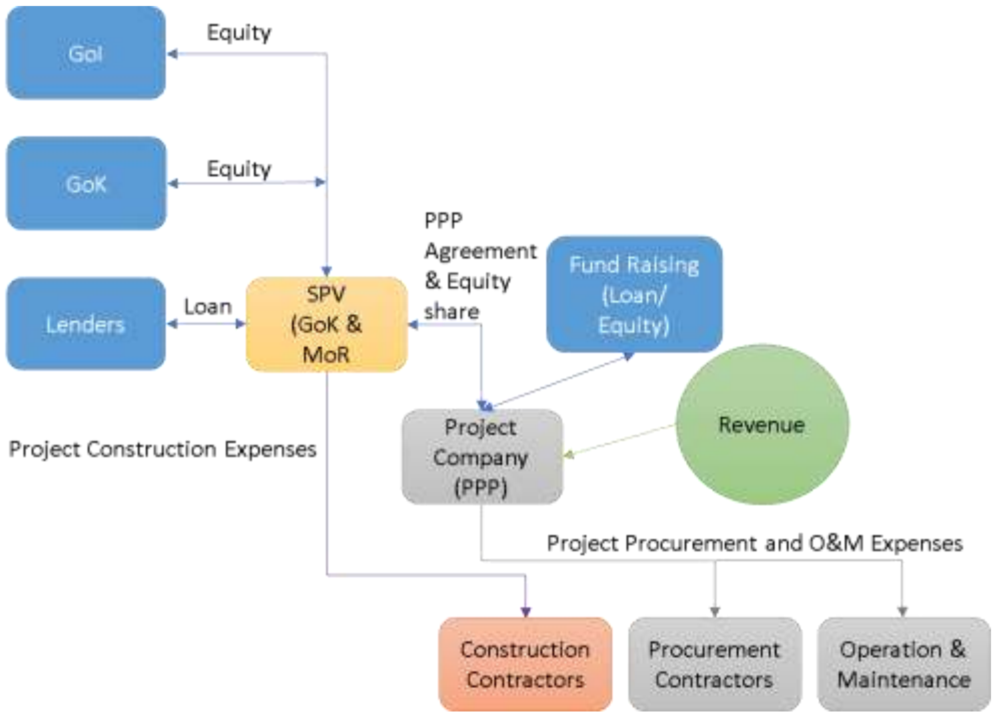


Figure 17-4: Option 4 Finance Model

- **Advantages-**
    - Better risk sharing - Capital intensive works, administrative issues handled by govt.
    - Multi- lateral funding support
    - Private sector efficiency in operations
    - Relatively easier contract management
    - In case of default in meeting performance standards, the PPP partner can be far more easily replaced
- **Disadvantages-**
    - Requires better co-ordination between stakeholders
    - Lessons to be learnt from issues in Delhi Airport Metro contract
    - Specific advantages in relation to innovation in design, construction would be limited.
    - Require additional investments by Private Sector for capacity augmentation and replacement.
    - Difficulty in controlling quality of system procurement and operation.

17.2.2.5 Option 5 - Leasing of Rolling Stock

.It is again a leasing finance model in which SPV delivers all the scope except the procurement of Rolling Stock and the maintenance of the Rolling Stock. The procurement and maintenance of the Rolling Stock shall be provided by a Private concessionaire against an annual lease rental paid by the SPV. The fund for the procurement of Rolling Stock and the maintenance shall be raised by the Private

concessionaire. The SPV will pay the annual lease charges based on the agreement for operating the Rolling Stock and maintenance services.

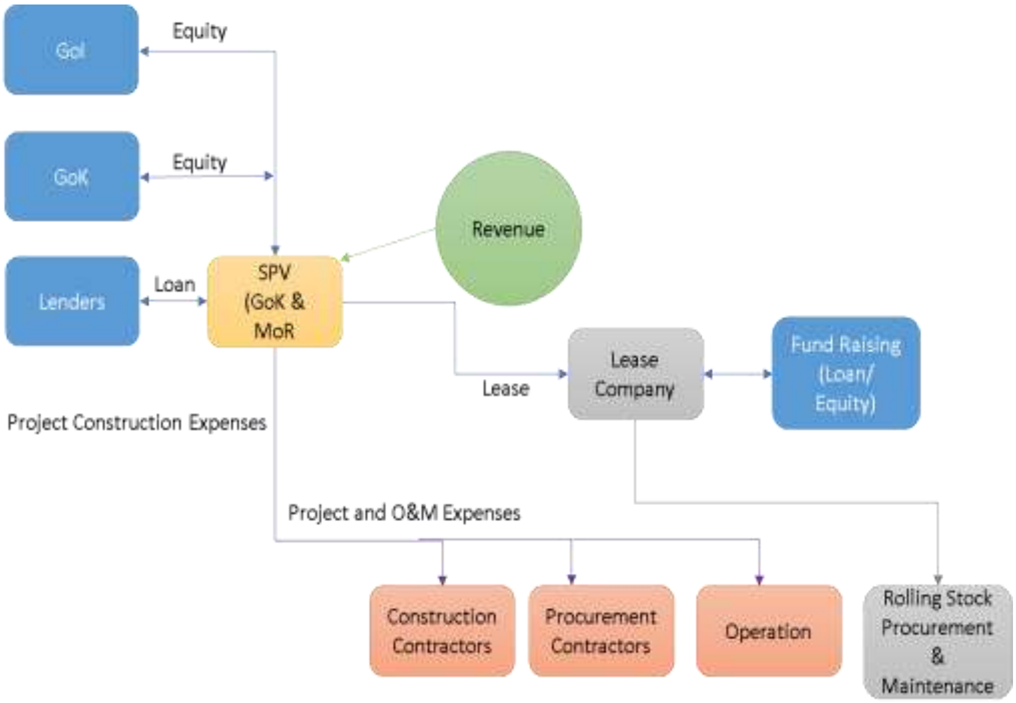


Figure 17-5: Option 5 Finance Model

It may also be possible that, public sector finances both civil infrastructure and procurement, owns all assets, takes ridership risk, and collects fare from commuters. Private sector implements operation by their own expenditures. Public sector makes payment for certain amount of management fees to Private sectors towards the operations rendered by them. This PPP Gross Cost method has been applied for Green Line Extension and Purple Line in Thailand.

- **Advantages-**
  - The Rolling Stock procurement and maintenance is managed by private player
  - The reliability and availability of the service is improved considering the experience of the private player
- **Disadvantages-**
  - Lease to be paid by SPV irrespective of the fare box revenue.

17.3 GLOBAL HISTORY OF HIGH-SPEED RAIL FINANCING

Reviewing the history of high-speed rail development, construction, and operation projects, we can identify three key financing trends in the development of high-speed rail systems. The first phase encompasses early Japanese and French projects such as the Tokaido Shinkansen line and the Paris-Lyon TGV line, which were funded and

(initially) operated entirely by public entities and agencies. The Tokaido Shinkansen line was constructed between 1959 and 1964, with the first train running in the year 1964, while the TGV Sud-Est line opened in 1981 after a 2-year construction period. Both projects became extraordinarily successful and quickly achieved financial profitability, as both lines were able to recover their full capital construction costs within the first decade of operations.

Both the Japanese and the French projects were developed in regions with a much higher population density. Furthermore, the Tokaido Shinkansen line was also constructed in a time when domestic and international commercial air travel only started developing and was far from its current scope; thus the line provided a viable substitute to air travel from the beginning on, which further explains its exceptional ridership and operational profitability.

The second phase of high-speed rail construction and operation projects was sparked by EU directive 91/440 which required EU member states to liberalize rail services and to open the domestic rail markets to induce increased private sector participation in high-speed rail services. Owners of high-speed rail infrastructure were forced to make rail systems accessible for all kinds of operators, public as well as private, which had not been the case previously as most European lines were operated and managed by a single state-owned entity. This directive generally led to a separation of the infrastructure owners from the HSR system operators, which could now compete to operate trains on different routes. A similar development also took place in Japan when the government privatized its high-speed rail system operations after the Japan National Railways became financially insolvent in 1987. This separation of infrastructure owners from high-speed rail operators in Europe and Japan has produced both public and private, operationally profitable, and financially successful rail operating companies.

The third phase of HSR developments consists of projects in which private companies have not only participated in the operation of the HSR system but have actively participated in the construction and development of the high-speed rail infrastructure through public-private partnerships. Public-private partnership have been structured in several ways, including, but not limited to, the provision of private equity and debt sources in the (partial) financing of capital construction costs. Other aspects of public-private partnerships involve EU, federal, or state credit and loan guarantees in privately financed construction projects to secure or ‘insure’ the private stakeholders against operational unprofitability. Overall, only two HSR projects have been developed that were entirely privately financed. These two projects include the Taiwanese HSR Corporation and the Channel Tunnel project. The Taiwanese corporation planned to finance the construction and operation of an HSR line through the projected operating surplus. However, it quickly became clear that the project required public credit support to finance construction and initial operation as initial

ridership turned out below expectations. The Channel Tunnel project on the other hand has encountered even more severe problems than the Taiwanese corporation. During its construction, the private developers, i.e. the Eurotunnel group, had to seek additional public government and state funding on several occasions. Upon completion and initial operation of the tunnel's rail line, it became clear that the private HSR system operator would require operating subsidies or would need to be restructured to stay financially solvent. The public equity contributed to the Channel Tunnel project has declined drastically in value and no dividends have been distributed to shareholders.

From this brief historical overview of HSR project financing, we can draw following conclusions:

- Traditionally, the infrastructure construction and development costs of large-scale highspeed rail projects have often been almost entirely public funded. In many countries, state-owned, public entities retain ownership of the high-speed rail infrastructure.
- Private Sector players are interested in implementing a part of the physical infrastructure or Operations and Maintenance, if they find the same viable.
- Projects that have initially relied entirely on private financing have not been able to be sustain and had to be restructured to include public funding participation.

17.4 INDIAN HISTORY OF HIGH-SPEED/METRO RAIL FINANCING

17.4.1 Mumbai -Ahmedabad High Speed Rail Project

India has started work on its first high speed rail project. Hon'ble Prime Minister of India and Japan laid the foundation stone for the High Speed Rail (HSR) project between Ahmedabad and Mumbai, a distance of 508.09 km, out of which 154.76 km of the proposed alignment falls in Maharashtra, 349.03 km in Gujarat and 4.30 km in UT of Dadra and Nagar Haveli.

Ministry of Railways, Government of India has setup High Speed Rail Corporation of India Limited (HSRC) in 2012 for development and implementation of high speed rail projects. The feasibility of the project was done by JICA (Japan International Cooperation Agency) and Ministry of Railways in 2013. However, the government created a special purpose vehicle National High Speed Rail Corporation (NHSRCL) in February 2016 for implementing the project of high speed train corridor between Ahmedabad and Mumbai.

The total cost of the project is estimated around US$ 17 billion (INR 1.08 trillion). The project is funded by JICA, committing about 85% of the total cost of the project as loan with an interest rate of 0.1% and a moratorium of 15 years and repayment period of

50 years. It is understood that the loan has been availed as a tied loan from JICA .The remaining cost will be borne by the Government of India and the state governments of Maharashtra and Gujarat in the ratio of 50:25:25..

17.4.2 Delhi-Ghaziabad-Meerut Corridor of Regional Rapid Transit System and Metro in Meerut

The first regional Rail system between Delhi- Ghaziabad-Meerut with a metro system in Meerut is being constructed over 82 kilometres at an estimated project Cost of Rs 30,274 crores. This distance of 82 kilometres would be covered in less than 60 minutes by high-speed, high-frequency trains.

NCRTC is mandated to design, construct, finance, operate and maintain RRTS in NCR and works under the administrative control of Ministry of Housing and Urban Affairs, Government of India.

The equity structure of NCRTC is broadly similar to other metro companies in India in which the equity participation of Government of India and participating states is in the ratio of 50:50. The balance cost shall be funded by external loan provided by ADB.

17.4.3 Metro Companies constructed, financed and operated by SPV of Central & State Govt.

In India, most of the metro projects are implemented through a Special Purpose Vehicle (SPV), that is set up as a joint venture between Central Government and State Government for the implementation of the project and for its subsequent Operation & Maintenance.

Under this arrangement Government of India and State Government make equal equity contribution and run SPV as a commercial enterprise.

As per the prevalent practice, Central Government contribute 20% of the project cost as their equity contribution. An equal amount can be contributed by State Government aggregating the total equity to 40%.

Remaining 60% is arranged as soft loan from funding agencies.

This mode of project execution is highly successful as it has the full government support. Such projects are excellently controlled and receive administrative and policy level support. Clearances and approvals are fast as the SPV employs governmental officials from the various liaison offices to speed up the entire process. The structure is also supported by multilateral financial institutions who provide project finance at low rate of interest.

Delhi Metro Rail Corporation, Bangalore Metro Rail Corporation, Chennai Metro Rail Corporation, Lucknow Metro Rail Corporation & Kolkata Metro Rail Corporation are some of the examples of success of such a SPV.

It is seen that all these Metros are highly successful and have a very high public patronage. They have resulted in decongesting cities and have been able to expand their rail network continuously due to their success.

17.4.4 Metro Companies constructed, financed and operated partly or fully by Private Sector

Some metros rail organisations have also been fully/ partly implemented under by the private sector, details of which have been presented through the following case studies.

Case Studies:

I. DELHI AIRPORT LINE UNDER PPP MODEL

DMRC has implemented a High Speed Airport Link from New Delhi Railway Station to IGI Airport and further extension to Sector-21, Dwarka covering a distance of 22.7 KM with private sector participation. The project with an estimated cost of Rs. 3869 Crore has been implemented under a unique model of PPP where in the DMRC has undertaken the civil works with the funds being contributed by GoI, GNCTD, Delhi International Airport Limited and DDA (54%) and the cost of systems and Rolling Stock (46%) is being met by the private operator who will operate the system for 30 years, after which the system will revert back to DMRC. The approved funding pattern is depicted below. There have been some issues with the concessionaire and DMRC is now operating the system.

The approved funding pattern of the Delhi Airport Line is depicted below:

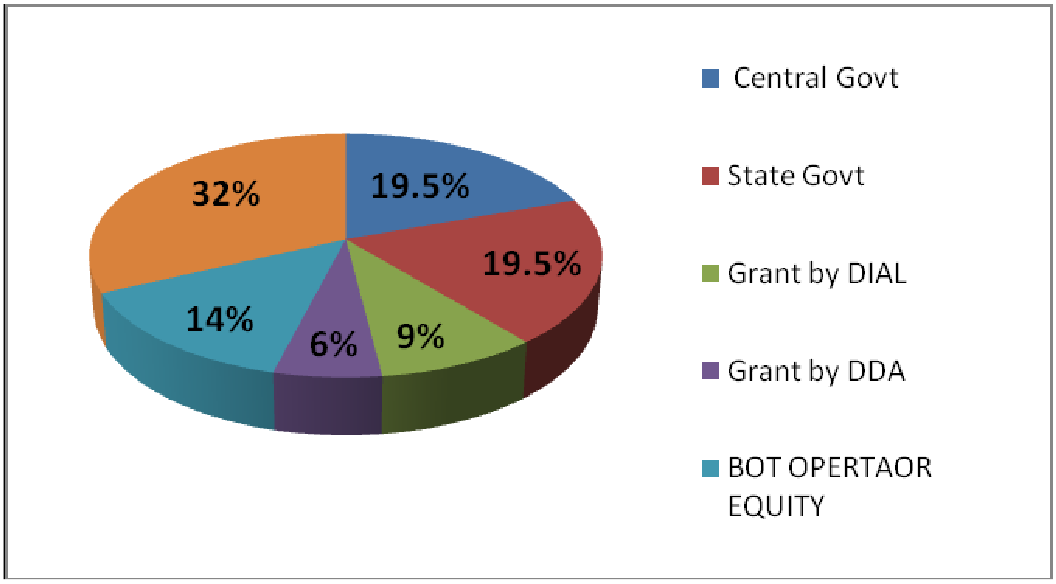


Figure 17-6: Approved funding pattern of the Delhi Airport Line

II. HYDERABAD METRO UNDER PPP MODEL

Hyderabad Metro is the first PPP Metro Rail Project that has been sanctioned by Government of India. GoAP has undertaken the Hyderabad Metro Rail Project

under Viability Gap Funding (VGF) scheme of GoI. The MRTS network include three high density traffic corridors with total length of about 71 km. The Project is being executed by L&T on design, build, and finance, operate and transfer (DBFOT) basis. GoAP will spend another 1,980 Crore towards land acquisition, R&R package, shifting of utilities and GoI will support the project with grant of 1,458 Crore as VGF.

The approved funding plan of Hyderabad metro is depicted below:

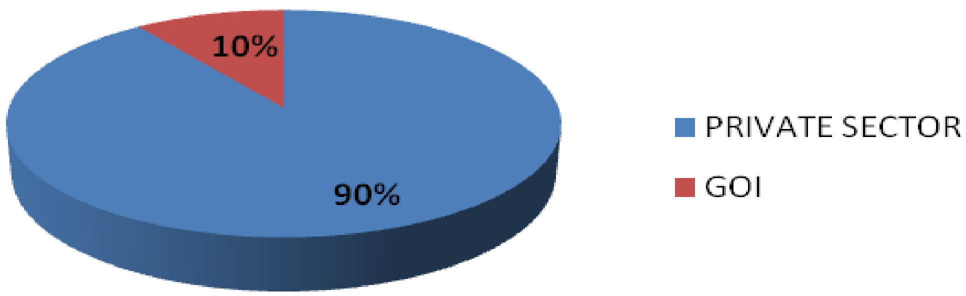


Figure 17-7: Approved funding pattern of the Hyderabad Metro Line

III. MUMBAI METRO LINE 1 & 2 UNDER PPP MODEL

In contrast to the SPV model adopted for construction of metro rail system in the city of Delhi, Bangalore, Chennai & Kolkata, the Maharashtra government has opted Build Own, Operate & Transfer (BOOT) model in the city of Mumbai.

So far, 2 lines covering a distance of 44 KMs (Line 1 of 11.07 KMs from Versova – Andheri -Ghatkopar with a total cost of Rs. 2356 Crore and Line 2 of 32 KMs from Charkop – Bandra –Mankurd with an estimated cost of Rs. 8250 Crore) have been awarded to private operator for construction and operation by giving Viability Gap Funding by GoI & Maharashtra State Government to the extent of Rs. 650 Crore and Rs. 1532 Crore for Line 1 & Line 2 respectively.

Mumbai Metro One Private Limited is a Joint Venture Company formed by Reliance Energy Limited, a Reliance ADA Group Company, Veolia Transport, France and Mumbai Metropolitan Region Development Authority (MMRDA) incorporated under the Companies Act, 1956 to implement this project. The approved funding pattern of Mumbai Metro Line 1 is given below. Line 1 is now operational. There were some issues with the concessionaire in the Line 2 and the implementation mechanism for Line 2 has been undertaken by the SPV of Government of India and Government of Maharashtra.

The approved funding pattern of the Mumbai Metro Line 1 is depicted below:

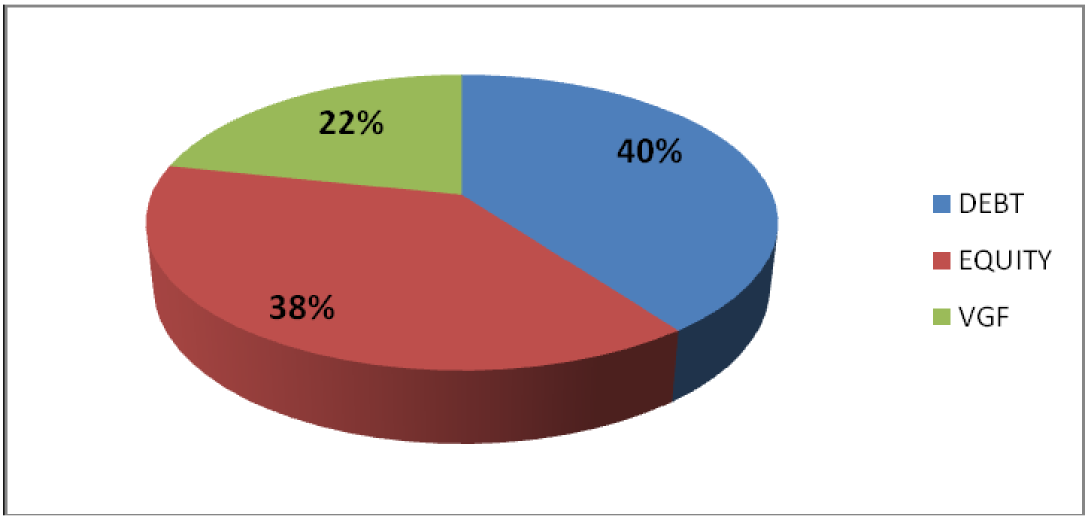


Figure 17-8: Approved funding pattern of the Mumbai Metro Line 1

IV. PPP in Bangalore Metro – Stations & O & M

Bangalore Metro Rail Corporation Ltd (BMRCL) has signed a memorandum of understanding (MoU) with the Embassy Group to build the Kadubeesanahalli Metro station. Embassy Group will pay Rs 100 Crore to BMRCL in instalments. The group is the first corporate to sign the agreement under the public-private partnership scheme.

The station, to be located just outside the Embassy Tech Village on the Outer Ring Road, will be on the recently approved 17-km North-South Metro corridor linking Silk Board Junction with Krishnarajapuram.

The construction will be done in accordance with the façade designs and specifications approved by BMRCL.

The period of concession and permission granted to Embassy Group will be for 30 years starting from the date of commencement of commercial operations and could be extended further on mutual terms. The agreement mandates that the group will maintain Kadubeesanahalli Metro station, including housekeeping and maintenance, along with all the equipment, according to specifications laid down by the corporation.

The partnership also means the group will be entitled to utilize the pre-determined spaces for advertisements. Embassy can also use the leasable retail space measuring approximately 3,000 sq. ft at the Metro station. Embassy will also have the advantage of leveraging the linear zone of 250 metres around the Kadubeesanahalli Metro station.

To summarize, In India, rail and metro projects are being executed both under the government funded models as well as under private sector models. It is also seen

that private sector models are possible to be implemented in highly congested cities or selected places where the financial returns are lucrative. As these private sector models are primarily based on financial returns only, it is risky to implement the same considering a going concern basis and few of these unprofitable projects had to be salvaged by the Government.

The below table gives an understanding of the ownership structure of most rail and Metro Projects in India:

Table 17-1: Ownership details of most rail and Metro Projects in India

Rail / Metro Project	Ownership	Remarks
Mumbai- Ahmedabad High Speed Rail	Government	Government of India 50%, Government of Maharashtra-25% and Government of Gujarat 25%
Delhi-Ghaziabad-Meerut Corridor of Regional Rapid Transit System	Government	Government of India 50%, Government of NCT Delhi-12.5% and Government of Uttar Pradesh-12.5%, Government of Rajasthan-12.5%, Government of Haryana- 12.5%
Kolkata Metro	Government	Ministry of Railways
Chennai MRTS	Government	Ministry of Railways
Delhi Metro 5 Lines	Government	GOI and NCR - Equally
Delhi Metro Airport Express	PPP	Implemented as Hybrid Two-tiered PPP, Civil by DMRC, Rail Systems by Reliance ADAG group. Due to issues with ADAG, DMRC has taken over all the operations.
Bangalore Metro	Government	GOI and GOK - Equally
Chennai Metro	Government	GOI and GOTN - Equally
Gurgaon Rapid Metro	Private	DLF backed out of the DLF- ILFS consortium due to cash flow problems. Operated by IL&FS solely.
Jaipur Metro	Government	Govt of Rajasthan..
Hyderabad Metro	PPP	Initial concessionaire failed to achieve financial Closure. Subsequently in fresh bidding L& T was awarded the contract on DBFOT.

Rail / Metro Project	Ownership	Remarks
Mumbai Metro 1	PPP	Awarded to Reliance AGAG consortium on DBFOT
Mumbai Metro Line 2,Line 3, Line 4	Government	GOI & GOMH- Equally
Pune Metro Rail Line 1, Line 2	Government	GOI & GOMH- Equally
Pune Metro Rail Line 3	PPP	Awarded to Reliance Tata Reality - Siemens JV on DBFOT
Bhopal Metro & Indore Metro	Government	GOI & GOMP- Equally
Lucknow Metro Rail	Government	GOI & GOUP - Equally
Kanpur Metro Rail	Government	GOI & GOUP - Equally

17.5 SOURCES OF FUNDS

17.5.1 Equity

The equity capital is to be provided by Government of Kerala and Government of India. A part of the equity capital can also be raised through public participation. The stakeholders who get benefited with the coming up of the project can contribute by sharing the cost of land/stations.

17.5.2 Subordinated Debt

As per the latest guidelines of GoI, the cost of Land including rehabilitation and resettlement cost may be contributed as interest free subordinate debt by State Government. Similarly, subordinate debt is provided by Central government & Government of Kerala for the central taxes & State taxes respectively.

17.5.3 Debt

The balance cost is to be met through loans from various institutions namely loans from JICA/ADB/World Bank/KFW/AFD/EIB/NDB etc or loans from domestic financial institutions. The union cabinet chaired by the Honourable Prime Minister has given its approval for modification of existing guidelines of the policy on bilateral official development assistance for Development Cooperation from bilateral partners.

Accordingly, Japan International Cooperation Agency(JICA) will extend a modified step loan for funding the new projects in India at about an interest rate of 0.20%- 0.30% per annum. The tenure of the loan is about 40 years including a 10 - 12 years moratorium period. JICA can fund the project to the extent of 100% of the cost of the total project. However, it shall be subject to the condition that procurement of capital works representing 30% of the loan amount shall be procured from Japan/ Japanese companies.

ADB/World Bank/KFW/AFD/EIB/NDB etc and other bilateral and multilateral institutions can also provide loan assistance for the project. The interest rate is linked with prevailing 6 monthly LIBOR/ EURIBOR and will include a spread. Accordingly, these bilateral funding institutions charge interest rates approximately ranging from 200 basis points to 300 basis points for USD loans and about 25 to 50 basis points for the Euro loans. Also, the loan funds provided by these multilateral institutions are generally restricted to 50% of the total project cost excluding taxes. Funds can also be arranged from domestic financial Institutions like India Infrastructure Finance Company Limited (IIFCL), Infrastructure Development Financing Corporation Ltd (IDFC), Life Insurance Corporation of India (LIC), IDBI Bank Ltd, ICICI Bank Ltd etc. All the bilateral / multilateral financial institutions as well as the domestic banks can extend credit to the SilverLine Project against a guarantee of the loan repayments from the Government of India.

17.6 ROLE OF LENDERS

Multi-lateral funding agencies such as JICA, World Bank, Asian Development Bank (ADB), KFW,AFD,EIB,NDB etc have shown keen interest in funding infrastructure projects that are capital intensive and have a long gestation period. These projects are typically backed by central government guarantees towards repayment of the loan. Typically, the loan repayment will be done from the SPV. If the SPV is not able to repay the loan instalment then the liability shall devolve on the Government.

A project of this size would require, ideally soft loan from a bi-lateral / multi- lateral funding institution on attractive terms and over a longer repayment tenure with lowest interest rate. We believe that the SilverLine project could obtain a soft loan from suitable bi-lateral / multi- lateral funding institution e.g JICA, World Bank, Asian Development Bank (ADB), KFW,AFD,EIB,NDB etc

17.7 ROLE OF GOVERNMENT

Government contribution is essential to keep debt-servicing levels of high speed rail projects low with a view to maintain overall long term sustainability of the system.

Government involvement also generates considerable amount of confidence in other players involved in the process of construction & operation. The Land acquisition strategies etc. are to be taken care by the Government.

17.8 CONCLUSION AND WAY FORWARD

Based on the above discussions, following conclusions are drawn:

- The development of transportation systems takes place in a socioeconomic context.

- High Speed/ Semi High Speed Rail Projects involve high project cost and long gestation periods.
- These projects generate medium financial returns with huge social benefits and hence have a good EIRR~~.~~
- These projects are attractive due to the low rate of interest loans available from the bilateral / multilateral funding agencies that are made available to the Government funded projects and the interest free subordinate loans provided by the Government.
- .As these projects have long gestation periods, loans of longer tenure may be preferred to ensure the sustainability of the project.
- PPP is generally not a viable option, even with Government subsidies, due to the high cost of funds and high return expectations of the private sector.

Way Forward

We have evaluated the project on Government funded (SPV) model and under the Private Participation (DBFOT) model as covered more extensively in Chapter 19 and found that SPV model is suitable for the implementation of this SilverLine Project, and the same can be combined with equity contribution through public participation, if so desired and acceptable to all the stakeholders.

Various modes of Public Private Partnership(PPP) are also possible for the SilverLine project. One or more combinations of the PPP models can be explored based on the interests shown by the private sector during the execution of the project. In particular SilverLine Project may offer scope on the following areas of PPP:

1. Power supply through installation of solar panel through private sector.(Already conceived)
2. Procurement of Rolling Stock and operations & Maintenance by private sector
3. Procurement and operations of RORO services by private sector
4. Procurement and Operation of Tourist trains by Private sector.
5. Station development and property development by Private sector.
6. OFC backbone network and LTE network by Private sector.

DETAILED PROJECT REPORT

SEMI HIGH SPEED RAIL CORRIDOR
THIRUVANANTHAPURAM TO KASARAGOD

VOLUME II - MAIN REPORT
(PART D)

CHAPTER 18
PROJECT IMPLEMENTATION PROGRAM & SCHEDULE

18 PROJECT IMPLEMENTATION PROGRAM & SCHEDULE

18.1 INSTITUTIONAL ARRANGEMENTS

Railways come under the “Union” list and therefore are the responsibility of Central Government. After independence all Railway lines meant for carrying passengers have been funded entirely by Central Government through successive railway budgets with the sole exception of Konkan Railway. Construction, operation and maintenance of Semi High Speed Railway lines also therefore come under the statutory responsibility of the Central Government.

In view of the growing demands for Railway Lines in various States and huge requirement of funds to execute them, Ministry of Railways has taken an initiative for setting up of Joint Ventures with States for focused project development, resource mobilization, land acquisition, project implementation and monitoring of critical rail projects. Kerala Rail Development Corporation (popularly known as K-Rail) is such a Joint Venture Company under Government of Kerala and Ministry of Railways, for complementing Indian Railways in augmenting the Railway Infrastructure within the State of Kerala as per the aspirations of the people of Kerala.

The Semi High Speed Rail (SilverLine) project from Thiruvananthapuram to Kasaragod should therefore be taken up under the same, with the technical guidance and participation of Ministry of Railways.

Semi High Speed/High Speed Railway Line projects are not generally financially viable projects and PPP is generally not a viable option for such projects, even with Government subsidies, due to the high cost of funds and high return expectations of the private sector. High Speed/ Semi High Speed Rail Projects involve high project cost and long gestation periods. These projects generate medium financial returns with huge social benefits and hence a good EIRR. These projects are attractive due to the low rate of interest loans available from the bilateral / multilateral funding agencies that are made available to the Government funded projects and the interest free subordinate loans provided by the Government. As these projects have long gestation periods, loans of longer tenure may be preferred to ensure the sustainability of the project.

Such a huge project, with new and complex technologies, can be handled better by a focused project organization. Konkan Railway is a shining example of how a huge Railway project can be implemented and operated by a Special Purpose Vehicle. A similar strategy for implementing this SilverLine Project is therefore recommended.

The entire process of setting up the SilverLine project comprises of four major stages/steps for the efficient and successful implementation & commissioning of project as explained in Figure 18.1.

K-Rail has a set of laid down strategies on one side and the factors/forces that have to be formulated and made to work in unison, so as to get the desired results using the driving forces.

These strategies & driving forces differ during the three phases namely design & detailing, construction, procurement & implementation and finally during operation & maintenance. The manpower required and the parameters to be controlled are more during the construction phase, less during the design & detailing stage and a lean organizational structure during operation & maintenance.

Each of the truncated pyramid has to work towards the common strategies adopted by K-Rail and activate the driving forces in tune with the same.

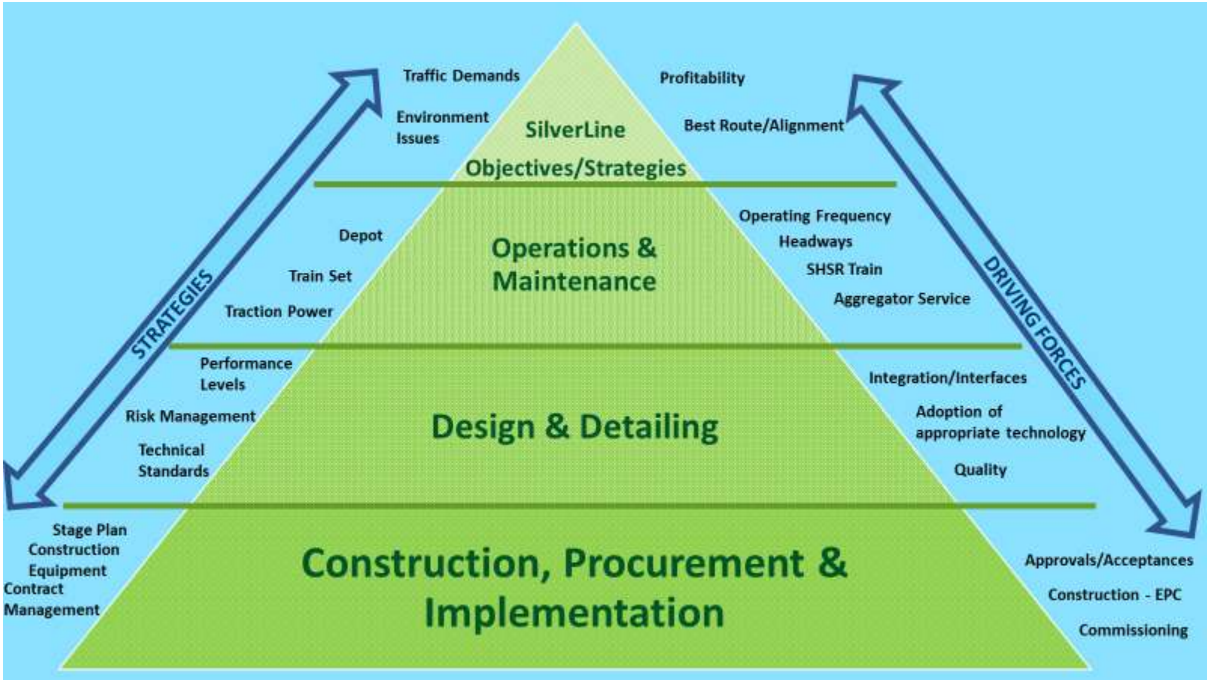


Figure 18-1: Major steps involved in implementation & commissioning of SilverLine

The composition of K-Rail is shown in Table 18-1.

Table 18-1: Composition of K-Rail

Sl. No.	Position	From
1.	Chairman	Government of Kerala
2.	Managing Director	Selected jointly by Government of Kerala & Ministry of Railways
3.	Director (Project & Planning)	Railways Nominee

Sl. No.	Position	From
4.	Director (Business Development & Finance)	Government of Kerala Nominee
5.	Director	Government of Kerala Nominee
6.	Director	Government of Kerala Nominee
7.	Director	Railways Nominee
8.	Director	Railways Nominee

18.2 NEED FOR SEPARATE SPV COMPANY FOR IMPLEMENTING SILVERLINE PROJECT

As per Article 7 of the JV agreement between Ministry of Railways & Government of Kerala, role of subsidiaries is as under;

- Subject to applicable law and consent of the parties, the JVC from time to time, incorporate project specific subsidiaries (Project SPVs) if necessary, to undertake viable railways projects identified by the parties in consultation with each other, or the Board.

- The project SPVs will be incorporated as limited liability company (ies) under the Act.

- The initial equity in the project SPVs will be contributed by the JVC. Accordingly, the MOR and GOK will infuse equity in project SPVs only through the JVC (and not directly) and hence, subject to Article 8 (Participation by other stakeholders). The project SPVs will remain a subsidiary of the JVC unless otherwise mutually agreed between MOR and GOKL.

- All the rights of the parties contained in this Agreement with respect to the governance of the JVC, will be mutatis mutandis available in the project SPVs (as and to the extent applicable) will incorporate the provisions of the Agreement and the Memorandum and Articles of Association of the JVC. Without prejudice to the generality of the foregoing all provisions of this Agreement relating to the Board and its meeting will mutatis mutandis be

applicable to the proceedings, decisions and action of the board of directors of Project SPVs and committees of the board of directors of Project SPVs.

- However, notwithstanding the foregoing, in the event a Project SPV no longer remains a wholly owned subsidiary of the JVC (due to change in shareholding in accordance with Article 8 & below) then the Project SPV will, at all times have a nominee of the JVC on its board.

Chhattisgarh Railway Corporation Limited (CRCL), counterpart of K-Rail in Chhattisgarh, who got approval of Railway Board for their two projects, has formed two Special Purpose Vehicles in the form of company. The SPVs are Chhattisgarh Kharsia Naya Raipur Railway Limited and Chhattisgarh Katghora Dongargarh Railway Limited. Both the companies were formed as wholly owned subsidiary companies of CRCL and Board of the subsidiary companies comprises of Directors of CRCL and Government of Chhattisgarh and Ministry of Railways. It is learned that now they are in the process of inducting other equity partners.

In line with JV Agreement and practices in other states, formation of SPV in the form of a company will be needed for undertaking this SilverLine project from Thiruvananthapuram to Kasaragod.

Kerala Rail Development Corporation Ltd (K-Rail) was established pursuant to the joint venture agreement executed between Government of Kerala and Government of India. In terms of the provisions of joint venture agreement, each project needs to be executed through a special purpose vehicle in the form of a company. Hence the project will be executed through Special Purpose Vehicle (SPV) in the form of a subsidiary company of Kerala Rail Development Corporation Limited. This SPV will execute the project and operate and maintain the system on behalf of the two Governments totally independent of Indian Railways. K-Rail will also form another SPV for the land bank development beyond the station areas by acquiring land. The two separate SPVs is necessary for value capturing but to ring fence the risk and avoid risk contamination. The surplus funds generated through the land bank development SPV can be rolled back to the project SPV by Kerala Rail Development Corporation Ltd to improve the cash flow of the Project SPV.

The implementation of SilverLine project and land development will be done by two separate SPVs (Special Purpose Vehicle) under K-Rail. The Rail SPV will be in charge of implementation of SilverLine project and the purpose of the land development SPV shall be land bank development and promote transit oriented development in the vicinity of SilverLine stations. The two SPVs formed by K-Rail will appraise, implement, manage, operate and monitor the project development. The execution of TOD projects may be done through Joint ventures, Public Private Partnerships etc.

While the core station area development in the land owned by Rail SPV will be carried out by Land SPV on behalf of Rail SPV, the land outside core station area will be owned by Land SPV and the development of the same will be directly under the ownership of Land SPV. Land SPV will undertake such developments either under PPP modes or by raising adequate funds or as a combination. A tripartite agreement will be formed between Rail SPV, land development SPV and the concerned developer for taking up development in station adjacent and within station area. The Land Development SPV shall perform all transactions and activities for such land development activities on behalf of Rail SPV. The Rail SPV shall directly receive the lease/rent/revenue share in respect of core station area development as per the conditions of agreement with the developer. The Rail SPV shall pay a service fee to the Land SPV for carrying out such Land Development related activities on it's behalf.

As direct inflow of foreign funds is not allowed for Land Development activities and land purchase/rent, an **Alternate Investment Fund** (AIF) is formed, or an existing AIF shall be used for funding the Land Development SPV. The AIF shall have a sponsor and an investment manager. The AIF invests into the Land Development SPV either in the way of debt/equity. The Land Development SPV shall use the funding received from AIF to acquire land parcels along the corridor as identified by the SPV. However, in case land pooling is done, the requirement of external funding will decrease dramatically. The downside is that land pooling is a time-consuming effort and participation of state government and Urban local bodies is very important in this case. Joint Venture companies /Joint Venture agreements are formed between the Land Development SPVs and developers for different parcels of land along the corridors. The developer shall be responsible for development over the allocated parcel of lands.

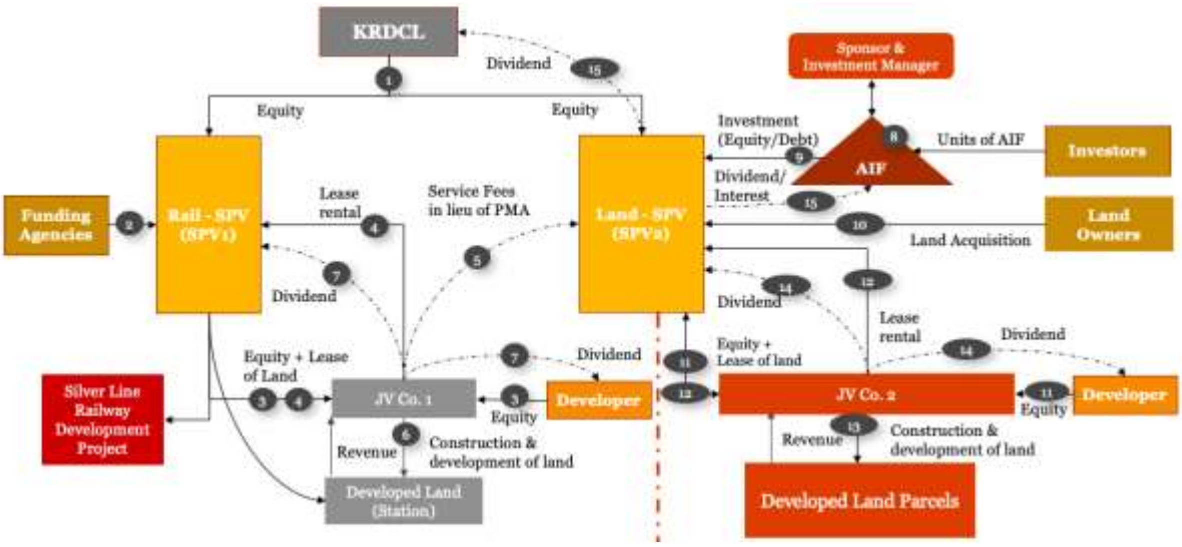


Figure 18-2: SPV Structure

Hence Special Purpose Vehicle (SPV) in the form of a company needs to be formed under Kerala Rail Development Corporation Limited (K-RAIL) for the implementation of SilverLine from Thiruvananthapuram to Kasaragod". The SPV company can be formed as a wholly owned subsidiary of K-RAIL and equity partner, if any, can be included at later stage.

18.3 OBSERVATIONS OF RAILWAY BOARD ON SILVERLINE PROJECT

A detailed proposal on proposed SilverLine project from Thiruvananthapuram to Kasaragod was presented before Railway Board, Government of India on 10th December 2019. The salient findings/observations of Railway Board, as communicated vide letter no. 2018/JV Cell/KRDCL/BD Meeting dated 18th December 2019, is shown hereunder;

- In view of various advantages of Standard Gauge on higher speeds and proven technology available world over, it was agreed in principle to proceed with Standard Gauge for proposed Semi High Speed Rail project from Thiruvananthapuram to Kasaragod.

- High Speed Rail project was not considered due to higher project cost. In view of inter station distance of 50 Km, the proposed speed of 200 KMPH is reasonable and acceptable compared with 160 KMPH for which technology is available in India.

- The alignment in Tirur-Kasaragod section is proposed parallel to the existing railway alignment. A portion of railway land will be used by the proposed alignment with a track centre of 7.8m. KRDCL confirmed that the cost of railway land used for the proposed project can be adjusted towards the Railway's share of equity in the SPV.

- Board has directed to explore the feasibility of PPP model for execution of the project.

- Board has directed to dilute the shareholding of Railways in the project SPV. KRDCL informed that as per the State JV agreement, the SPV shareholding by KRDCL can be reduced up to 26% of the total shareholding of the SPV.

- Railway Board has expressed concern about the land acquisition issues in Kerala. It was assured that all efforts will be made to acquire the land and proper compensation will be given to the affected parties.

- Railway Board mentioned the need for additional stops in Kerala. KRDCL clarified that additional feeder/aggregator stations limited to three are proposed between two main stations.

Railway Board's directions above are taken care of in the DPR appropriately.

18.4 DPR APPRAISAL/APPROVAL PROCEDURE

Ministry of Railways, Government of India has issued a guideline regarding procedure for evaluation and appraisal/approval of Detailed Project Report (DPR), submitted by State JV Companies to Zonal Railways, vide letter no. 2018/JVCell/Genl/SPV/Policy/2 dated 05.04.2018. As per this guideline, JV Companies shall submit DPR to (i) Zonal Railways for their evaluation, (ii) State Government for their approval & issue of Government Order and (iii) Stakeholders for their approval/consent. Thereafter, a project proposal with copies of DPR along with the following documents shall be submitted to Railway Board for sanction of Competent Authority;

(i) Resolution of BoD of JVC.

(ii) Approval of State Government in the form of Government Order.

(iii) Consent of other Stakeholders.

(iv) Project details on the prescribed formats.

(v) Status of pre-investment activities including process of land acquisition and incorporation of Project SPV.

18.5 IMPLEMENTATION STRATEGY AND SCHEDULE

It is expected about 1 to 1.5 years would be needed for setting up the SPV, obtaining approval of the project from the two Governments, engagement of General consultants and taking possession of lands for commencing the work.

18.5.1 Option I - Implementation in One Go

The construction and commissioning of the SilverLine can be done in one go for the entire route of 529.45 Kms from Thiruvananthapuram to Kasaragod, if the funds are available for the full project. The entire length of project can be implemented and commissioned over a period of five years from 2020-21 to 2025-26 (including approval, etc). Based on the “in-principle” approval received from Ministry of Railways, the land acquisition process can start since the funding for the same to be borne by Government of Kerala. Physical work can start after the project is approved by Government of India and financial closure is established.

This option is advantageous as it will be at the least cost as planned (avoiding unnecessary escalation) and will bring early benefits to the state including inter modal and integration benefits. However, this will require bigger teams of personnel for client, consultant as well as contractor to be deployed so that simultaneous designing, mobilisation, execution and reviews can be done with a large number of contractors working at the same time. Moreover, in such a case, there will be no benefits from lessons learned and also since at present many metro projects are under construction in India, there may be a problem of availability of manpower and contractors to undertake simultaneous work on the entire SilverLine length.

18.5.2 Option II - Implementation in Phases/Stages

If the project is taken up in parts, i.e. funds are available in stages, the whole project covering a length of 529.45 kms can be implemented and commissioned in a phased manner with first phase between Thiruvananthapuram and Thrissur and the second phase from Thrissur to Kasaragod as under;

- Phase I - Thiruvananthapuram to Thrissur (260 Km)
- Phase II – Thrissur to Kasaragod (270 Km)

Implementation in phases/stages has the following advantages;

- Staged commissioning will give benefit of reducing impact of unforeseen risks.
- Learning lessons from commissioning of Phase-I will make commissioning of rest phases smoother.
- Phased commission will reduce the peak load of design review and proof checking.
- Phased commission will enable SPV to provide on the job training to O&M staff to be deployed in remaining sections.
- Early revenue accrual will start as soon as one section is commissioned.
- Early relief to prospective passengers in the area covered by the SilverLine section being commissioned.

It is estimated that phase-I will take 4-4.5 years (including approval), and the entire project in 6- 6.5 years (including approval). In Phase I, the construction activities can be taken up commencing from Ernakulam (Kakkanad) towards Kochuveli (196 km) and towards Thrissur (64 km) - total of approximately 260 km, so that the coaches & RS can be maintained at Kollam depot. In Phase II, Thrissur to Kasaragod for 270 km can be taken up.

18.5.3 Recommended Implementation Strategy

It is recommended to go for the Option-I, i.e. Implementation and commissioning in one go since it will benefit the whole state at the earliest.

For implementation of SilverLine project, K-Rail has to monitor this project strictly as per the time schedule at every stage. It will have very important role of coordination with Ministry of Railways and other Government departments. Ministry of Railways will be also responsible for the enactment of the new Act/s needed for Operation and Maintenance of Semi High Speed Trains as these are being planned in our country first time.

The schedule for implementation of project in one go is shown in Table 18.2 and Figure 18.3 with the following major milestones;

- D - Date of In-Principle approval of project (base date).
- D1 – Date of start of work after In-Principle approval.
- D2 – Date of completion of detailed design & drawings and specification.
- D3 - Date of final approval & sanction of project.
- D4 – Date of completion of land acquisition.
- D5 – Date of award of work to the execution agency.
- D6 – Date of Completion of construction works.

Note: All the activities are linked with above milestones.

Table 18-2: Schedule for Implementation in One Go

Sl. No.	Milestone	Duration required	Start (month)	Finish (month)
1	Project Approval (In-Principle)		D	D
2	Preparation of Detailed Design & Drawings and Specifications	6 months	D+3 (D1)	D1+6 (D2)
3	Obtaining Technical Clearances from RDSO/Railway Board	4 months	D2	D2+4 (D3)
4	Project Approval and Sanction (Final)	10 months	D1	D3
5	Preparation and Finalization of Tender Documents & Drawings	6 months	D2	D3+2
6	Land Acquisition for the Project	18 months	D1	D3+8 (D4)
7	Tender Floating, Tender Evaluation and Award of Work	9 months	D3+2	D4+3 (D5)
8	Preparation of Tender Documents for PMC	6 months	D1	D2
9	Land Bank Tender	6 months	D1	D2

Sl. No.	Milestone	Duration required	Start (month)	Finish (month)
10	Floating and Finalization of PMC Tender	6 months	D3	D5-5
11	Mobilization of PMC Team	4 months	D5-5	D5-1
12	Quarry selection, Identification of Construction Material	3 months	D3-3	D3
13	Tender for Processing of Rolling Stock	12 months	D3+1	D5+2
14	Tender for Execution of System Work	12 months	D3+2	D5+3
15	Execution of Civil Works	33 months	D5	D5+33 (D6)
16	Execution of System Works (S & T, Power Supply, etc.)	12 months	D5+19	D6
17	Station and Area Development	36 months	D1+3	D5+18
18	Processing and Ordering for Rolling Stock (Import)	24 months	D5+9	D6
19	Testing, Commissioning & CRS Inspection	6 months	D6	D6+6

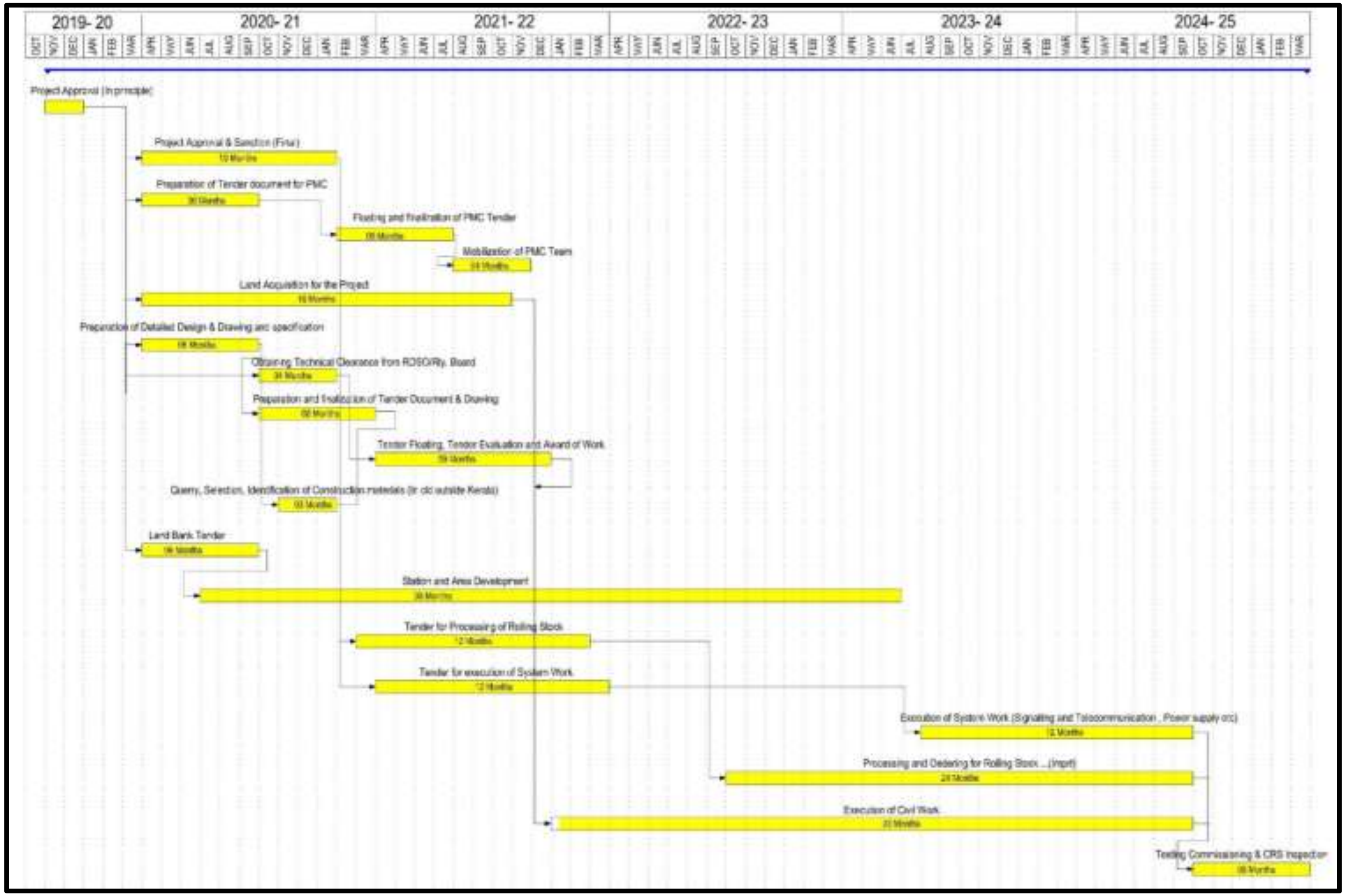


Figure 18-3: Schedule for Implementation in One Go

18.6 LEGAL COVER

The Indian Railways Act, 1889 is essentially for railway operations in the country where the speed is limited to 160 kms per hour. Although there is no mention in the Railways Act itself, it is obvious that for speeds beyond 160 kms per hour, special statutory provisions and safeguards will have to be incorporated. On the lines of the Metro Construction and Operations Act, an Act can be passed by the Parliament specifically for high speed operations where the speeds may be 200-350 KMPH. An independent assessor can be nominated initially, having support from the foreign agencies / countries who have vast experience in running the high speed trains. After introduction of the services, The Commissioner of Railway Safety can be nominated as the authority for inspection and certifying the line for carriage of passengers. The Project can be commenced under the Railway Act but by the time it is ready for operation the new High Speed Railway Act should be in enacted for smooth functioning of all high speed rail corridors in the country.

18.7 PRINCIPLES FOLLOWED IN PROVISION OF CROSS PASSAGES ACROSS SILVERLINE

- At every kilometre across the SHSR track, 2 cross passages of appropriate design shall be provided for the public to have access to the other side.

- Whenever existing roads get crossed by SilverLine, track a grade-separator bridge shall be constructed based on site conditions/requirements and the category of road. No level crossing will be provided across SilverLine track.

- As decided in the meeting held at Railway board on 10.12.2019, all the level crossings in Tirur- Kasaragod section which are not yet sanctioned for ROB, will be converted into ROB charging to this project estimate.

- Between Tirur & Kasaragod, in any particular kilometre, if either LC or ROB is already available, only one additional passage per km in the form of pedestrian subway shall be constructed for access to local public.

- For SilverLine track to cut across the existing ROB, suitable large size precast RCC boxes shall be inserted and the road may be regraded suitably, and the ramp length increased, duly consulting the road authorities.

18.8 CONSTRUCTION MATERIALS

18.8.1 Earth Work & Blanket

For the Earthwork on embankment and for blanket materials, quarries identified locally in the vicinity of SHSR track are proposed to be made use off. Such quarries shall be located one in 75-100km stretch along the corridor.

Additional land for approximate 5-10 He at each quarry site may have to be temporarily acquired. The locations identified are shown in the Table 18.3

Table 18-3: Quarry Area Location

Sl. No.	Pro Appx. KM.	Location	Coordinates		Area (Sq.Mtr)	Area (Ha)
			Easting	Northing		
1	22/600	Q01_Attingle	698325	962691	85977	8.60
2	22/200	Q02_Attingle	698739	959727	48152	4.82
3	65/000	Q03_Kundra	684776	991858	87359	8.74
4	65/400	Q04_Kundra	685117	992234	65180	6.52
5	123/000	Q05_Mahadevpuram	676850	1046918	58914	5.89
6	126/000	Q06_Mahadevpuram	675369	1049503	64852	6.49
7	181/000	Q07_Kanayannur	656295	1095800	108878	10.89
8	298/000	Q08_Naduvattom	610243	1190654	85226	8.52
9	390/000	Q09_Near Vellarakkad Railway Station	571779	1269938	158292	15.83
10	495/000	Q10_Kundill	515138	1349618	397122	39.71
Total Tentative Quarry Area						**116.00**

Besides the above the excavated/generated materials/earth etc from the cuttings, cut and cover locations etc shall be segregated and reused in the adjoining reaches of the project. This will contribute for large quantity of soil to be used as fill materials in embankments as well as for the subgrade and blanketing etc based on the suitability.

18.8.2 Ballast

Requirement of stone ballast is estimated to be approximate 28,60,000 m^3. It may not be possible to get this huge quantum of stone ballast from the quarries available in Kerala alone. Hence it is proposed to obtain permission from competent authority for quarrying and moving ballast from adjoining states of Tamilnadu and Karnataka.

The locations where in good quality stone ballast could be available in the adjoining states are,

i. Eraniel / Aralvaymozhi in Kanyakumari District of Tamilnadu.
ii. Madukkarai (Near Podanur) in Coimbatore District of Tamilnadu.
iii. Mangaluru / K.Puttur area in D.Kanada District in Karnataka.

18.8.3 Concrete & Drymix

i. 20mm Metal for concrete have to be arranged.
ii. For drymix 40mm metal have to be arranged and additional quarries for metal have to be identified.
iii. Consultation with Govt of Kerala for requirements from Tamil Nadu and Karnataka duly obtaining necessary approvals.

River sand shall be used for all the prestressed concrete construction and for all other concrete works M-sand shall be used.

18.9 LAND ACQUISION AND CONTRACTS

18.9.1 Land Acquisition

Land acquisition for the entire requirement of 1383 He for the project (and even the additional requirement under the Land SPV) has to be completed in a time period of 18 months to complete the project within the specified timeframe of 5 years and hence this is the most critical activity in the project. For this, the Land Acquisition Cells to be formed by the State Government should start the exercise of land acquisition immediately on obtaining the Kerala Cabinet's approval for the DPR. Physical acquisition and handing over of land to the project SPV should be done within 12-18 months from the date of approval of the DPR. As this is to be done under the 2013 Act, early action in setting up Land Acquisition Cells and granting Enter-upon Permission by the concerned authorities will help in smooth progress of the project. A general condition laid down by the Govt of India for such projects is that physical works in the field cannot be started unless 80% of lands required for the project are available to the project authorities. This condition may be difficult to follow in all conditions, particularly in the state of Kerala and also in view of phase-wise planning adopted in some projects. In such a situation, a considered view may be necessary for obtaining relaxation to the above condition as the project progresses.

Major activities and time distribution for Land Acquisition may be as under(this may vary based on the mode selected and directions of the Govt)-

- Forming Land acquisition cells and creating organisation in the field-1 month,
- Issuing preliminary notification 6 (i) and collecting ownership details -3 months,

- Enter upon the land for measurements and classification -3 months,
- Issuing subsequent notifications, conducting stake-holder meets -3 months,
- Working out Awards, Compensation, etc and publication -3 months,
- Enter upon for mobilisation -2 months,
- Taking over possession of land -3 months.

18.9.2 Contracts

The following type and pattern of contracts are considered for construction of the SilverLine.

For civil works, the complete project length needs to be divided into reaches or items (120-150kms each or specific items). All or most of the items in these reaches can be combined into viable Engineering, Procurement and Construction (EPC type involving field surveys, planning & designing, procurement of materials and machinery, construction, testing & commissioning) contracts or Other type contracts based on capacities (design, construction, procurement, execution, testing, etc) available as per overall planning of construction including funding. EPC type contracts are preferable for works or procurement of special nature requiring new technologies with variety of factors controlling rates and/or where contactors with good resources are available in adequate numbers. BOQ or other type contracts are resorted to works of routine nature where specifications and designs are clear and much variation in rates among contractors are not anticipated.

18.9.2.1 Civil works

Types of contracts can be as under-

- Long or special tunnels including track base – EPC
- Formation (bank and cutting including blanket), bridges, small viaducts-EPC
- Stations & Buildings (including MEP) – Other or EPC
- Long Viaducts including track base – EPC
- Track including Ballasting – EPC
- Depots (Workshops, sheds and other facilities) - Other
- Planning and Designing for Other contracts – Other
- Project Management Consultancy(PMC) for monitoring, supervision and proof checking - Other
- Procurement for Track maintenance machinery, Track monitoring system, Machineries for Systems, etc – EPC or Other.

18.9.2.2 System Contracts

- Design, manufacture, supply, installation, testing & commissioning of Signalling & Train Control.
- Design, development, manufacture, supply, testing, delivery, commissioning and integrated testing for Rolling Stock.
- Design, supply, installation, testing & commissioning of Traction & Power Supply system for mainline and depot.
- Design, construct and installation of lifts.
- Design, construct and installation of escalators.
- Design, supply, installation, testing and commissioning of Automatic Fare Collection System.
- Design and installation of track in depot and on mainline.
- PMC contracts.

18.9.2.3 Depot

- Detailed design contract for Kollam Depot.
- Detailed design contract for Kasaragod Depot.
- Contracts for Depot equipment.

18.9.2.4 Reach Planning

Planning of works for execution needs to be done in advance with proper phase-wise planning to commission the corridor fully or part by part duly assessing the funds availability in a given time frame , say 2 years, and also the items/quantities involved in such works. Number of contracts in each reach will depend on the type of works as discussed above.

Ex- Thrissur to Thiruvananthapuram can be planned in 2 reaches with about 2 or 3 contracts in each reach. Similar arrangement between Thrissur and Kasaragod can also be planned.

This approach will enable mobilisation of required resources by each contractor effectively apart from inducing a feeling of competition among the contractors, particularly when suitable Bonus/Penalty clauses are provided in contract documents. However this approach will call for an effective coordinating mechanism in the PMC and SPV to sort out inter-contractor issues technical and non-technical.

18.10 CONCESSION FROM GOVERNMENT

SilverLine project may require very heavy investments. Loans may invariably be taken to fund the part of the capital cost of such projects. As India is a developing country and the citizens do not have income as high as in the countries like Japan, high and fancy fares may not be possible and hence viability of such projects may be possible only when certain concessions are extended from the Governments concerned. Hence it is recommended that State taxes should be refunded by State Govt. as subordinated debt, land should be provided free of cost by the State Govt. to be accounted as subordinated debt and Central taxes shall be refunded by Central Gov as subordinated debt. Further, a recommendation that State govt may take up with KSEB, for reduced concessional tariff for this SilverLine Project to reduce the energy bill and to make the project more viable.

18.11 WAY FORWARD

On receipt of Detailed Project Report, following action will be required for implementation of SilverLine project;

- On submission of Detailed Project Report to the State Government (already done), State Cabinet`s approval should be obtained for implementation of Detailed Project Report.
- The approved DPR should be forwarded to Indian Railways for their approval and also for their financial participation through equity contribution in the SPV.
- Signing of MOU between Government of Kerala and Ministry of Railways giving all the details of the Joint Venture bringing out the financial involvement of each party's liability for the loans raised, administrative control in the SPV, policies in regard to Fare Structure, Operational subsidy, if any, etc.
- Preparation of new Act by Indian Railways and enactment of the same by Parliament.
- State Government to freeze all the developments along the Corridor suggested for any construction within 30m either side from the centre line of the proposed alignment. A system of No Objection Certificate to be introduced for any construction within 30m either side from the boundary of the proposed alignment.
- Approval by NITI Aayog.
- Approval by the Extended Railway Board.
- Approval by Cabinet Committee on Economic Affairs (CCEA).
- Financial closure of the project including arrangement of funds (Loans, etc).
- Land acquisition of the Project.
- Detailed Designs and Drawings.

- Finalization of Tender Documents.
- Floating and award of Tenders.
- Recruitment and Training of Staff
- Execution of Civil, Electrical, S&T and other system works.
- Procurement of Rolling stock and other equipment.
- Testing, commissioning and CRS inspection.

DETAILED PROJECT REPORT

SEMI HIGH SPEED RAIL CORRIDOR
THIRUVANANTHAPURAM TO KASARAGOD

VOLUME II - MAIN REPORT
(PART D)

CHAPTER 19
FINANCIAL & ECONOMIC ANALYSIS

19 FINANCIAL & ECONOMIC ANALYSIS

19.1 INTRODUCTION

Economic viability of the SilverLine Project has been assessed within the broad framework of "Cost-Benefit Analysis", generally used for appraisal of public investment projects. In economic evaluation, benefits are computed for the economy as a whole. In case of financial analysis the profits become the major factor for evaluation whereas in economic analysis the benefits to the economy are the main criteria for evaluation.

19.2 SCOPE AND OBJECTIVES

The economic analysis involves comparison of project costs and benefits in economic terms under the "with" and "without" project conditions and determining the Economic Internal Rate of Return (EIRR) of the project using discounted cash flow technique. This shows the return which the society could expect from the proposed investment during the project life cycle i.e. analysis period. The EIRR is compared with the rate of return considered as the cut-off point for undertaking the investment by the Government of India and international funding agencies for determining the economic viability of the project. In case of investments to be financed by development banks the pursued EIRR is regularly above 14%.

19.3 APPROACH AND METHODOLOGY FOR THE ANALYSIS

19.3.1 Methodology for Economic Analysis

The main steps followed are:

(i) Estimation of Capital and Operations & Maintenance costs at economic prices, along with the capital cost phasing.
(ii) Estimation of economic benefits.
(iii) Comparison of annual streams of costs with benefits and computation of EIRR.

The Economic Project Cost and benefits need to be evaluated at economic values.. Therefore, economic factors are applied for converting the financial values of project cost and benefits to economic values.

The project is further subjected to sensitivity analysis by assessing the effects of adverse changes in the key variables on the base EIRR. This helps to gauge the economic strength of the project to withstand future risks and uncertainties.

The Appraisal Guidelines applicable for Metro Rail Projects Proposals' (2017) and 'Metro Rail Policy 2017' by the Ministry of Housing & Urban Affairs, Govt. of India have been considered in the calculation of EIRR.

Accordingly, economic feasibility analysis is carried out for both 30 year and 50 years operation period considering the following :

- Base Period (March 2020)
- Construction period (FY 20-21 to FY 24-25)
- Project opening for traffic (FY 25-26)
- Project operating period : Realistic Scenario : (FY 25-26 to FY 74-75), Conservative Scenario : (FY 25-26 to FY 54-55)

19.3.2 Conversion of Project Cost and Benefits to Economic Values

The economic costs of the capital works and annual operation and maintenance costs have been calculated from the financial cost estimates by excluding:

- Price contingencies/price escalations
- Import duties and taxes
- Sunk costs
- Interest payment, principal payment and interest during construction period

The costs incurred and the benefits derived from the project are not reflecting real resource cost and value of their benefits to the economy and they need to be adjusted for taxes, subsidies, inefficient land or wage markets, and other transfer payments before performing the economic analysis

The economic costs have been derived from financial costs using shadow price factor stated in Table 19-1 and Table 19-2 for each component to take care of the distortions brought by above factors.

Table 19-1: Factors Used for Converting Project Costs to Economic Costs

SL No	Item	Conversion Factor
1	Capital Cost	0.83
2	Operations & Maintenance Cost	0.87

Source : Appraisal guidelines for Metro Rail Project Proposals.

The benefits have been calculated for the project and the following factors have been used for converting their values into economic benefits.

Table 19-2: Factors For Converting Project Benefits to Economic Benefits

SL No	Item	Conversion Factor
1	Travel Time Savings to Passengers	1.00
2	Savings in Vehicle Operating Cost	0.90
3	Savings in Pollution Costs	1.00

SL No	Item	Conversion Factor
4	Savings in Accident Costs	0.90
5	Savings in Infrastructure/ Maintenance cost	0.87

Source : Appraisal guidelines for Metro Rail Project Proposals

19.4 ESTIMATION OF ECONOMIC PROJECT COST OF SILVERLINE PROJECT

19.4.1 Capital Cost

The Capital Cost includes the following components of capital cost of infrastructure - civil engineering, land, track, power supply, traction system, signalling & train control & communication etc, and rolling stock.

The Economic Capital Cost of the Project is detailed in Table 19-3.

Table 19-3: Economic Cost of the Project

Particulars	Amount (INR in Crores)
Project Cost excluding Price Contingencies, Import Duties & Taxes, IDC, etc	49,919
Conversion Factor	0.83
Economic Cost of Project	41,433

The Construction period for the project is five years from 2020-21 to 2025-26. The final payments are expected in the FY 2025-26. The Cost Outlay of the project based on Capital Cost phasing is detailed in Table 19-4.

Table 19-4: Project Cost Outlay

Financial Year	Financial Cost	Conversion Factor	Economic Cost
			(INR in Crores)
2020-2021	1,798	0.83	1,492
2021-2022	10,474	0.83	8,693
2022-2023	13,471	0.83	11,181
2023-2024	11,548	0.83	9,585
2024-2025	9,179	0.83	7,619
2025-2026	3,448	0.83	2,862
Total	49,919		41,433

19.4.2 Capital Replacement Cost

Capital Replacement Cost during the operation period has been considered at economic values for Track, Rolling stock, Traction & power supply equipment's and Signalling & train control and communication system.

Further, to meet the increased traffic requirements, augmentation is required for rolling stock which has also been considered at economic values.

The capital replacement requirement during various years in financial terms are detailed in para 19.9.4

19.4.3 O&M Cost

The O&M cost includes the staff cost, routine maintenance cost and the energy cost.

The Economic O&M Cost details are provided in Table 19-5.

Table 19-5: Economic O & M Cost

Particulars	Amount (INR in Crores)
Energy Cost	163.27
Staff Cost	270.74
Maintenance Cost	542.00
Total O & M Cost	**976.01**
Conversion factor	0.87
Economic O & M Cost	**849.12**

19.5 ECONOMIC BENEFITS OF SILVERLINE

Description of economic benefits and costs of the SilveLline Project requires the identification of the changes brought out by it in the transport sector of the economy in Kerala. Most importantly, SilverLine contributes to the diversion of a high proportion of current private traffic from Road to Rail and serves part of the growing passenger traffic and goods traffic demand in Kerala. As a result, there will be a reduction in the number of buses, passenger cars and other vehicles carrying passengers and goods vehicles on Kerala roads. There will be savings in travel time for passengers and goods moved by SilverLine due to higher speed and the residual traffic left on road will also be benefited due to reduced congestion. The SilverLine will also bring about a reduction in air pollution because of the substitution of electricity for petrol and diesel and enhances safety on the roads. There will also be a reduction in the number of accidents on the roads.

In addition, there will be health and other environmental benefits to the public due to reduced pollution from the transport sector of Kerala. Land and house property owners gain from the increased valuation of house property prices due to SilverLine.

While some of the above benefits are quantifiable, others are difficult to measure. For the proposed project, benefits from following were assessed:

- Savings in Travel Time (VOT)
- Savings from vehicle operation cost (VOC)
- Savings due to reduced Environmental Pollution
- Accident cost savings
- Savings due to reduced road stress

In addition, to the items quantified above, the community will be benefited by following factors which are difficult to quantify. These are listed below;

- Comfort
- Health Benefits.
- Savings in vehicular operating costs due to the diverted road and rail users to SilverLine.
- Land price increase

The commissioning of the proposed SilverLine project is expected to result in both direct and indirect benefits to the users. The present analysis covers quantification of direct benefits in terms of savings in time, VOC/fuel. Benefits due to improved environmental conditions and reduced accidents are also quantified using rapid techniques.

19.5.1 Basic Input Parameters

The basic input parameters corresponds to number of people travelling by other modes getting shifted to SilverLine and the modes getting off the road. This also includes goods traffic such as trucks above 2-Axle and MAVs. The base year is considered as 2019-20, commissioning year as 2025-26 and and benefits have been estimated upto 2074-75.

The daily ridership estimates of people (person trips) from different modes to SilverLine is converted to vehicle trips based on average occupancy. The observed and adopted occupancy are as follows :-

a) Car – 2.27
b) Bus – 28.5 (AC bus – 28 and Non-AC bus – 29)
c) Train – 1707 (average of conventional coach – 1634 and LHB - 1780 coach capacity)

Based on the above, the basic input parameters considered for economic parameters are provided in the Table 19-6.

Table 19-6: Basic Input Paramaters (person trips and vehicle trips)

Year	Rail Pax	Bus Pax	Car Pax	Rail (No.)	Bus (No.)	Car (No.)	Truck (No.)
2019	14658	14877	24751	9	522	10904	394
2020	15190	15435	25919	9	542	11418	402
2021	15907	16187	27199	9	568	11982	412
2022	16658	16976	28549	10	596	12577	423
2023	17446	17804	29974	10	625	13204	434
2024	18270	18672	31477	11	655	13867	445
2025	19133	19583	41218	11	687	18158	457
2026	19967	20377	43032	12	715	18957	468
2027	20838	21202	44935	12	744	19795	479
2028	21747	22061	46930	13	774	20674	490
2029	22695	22954	49023	13	805	21596	502
2030	23684	23884	51220	14	838	22564	514
2031	24458	24529	52953	14	861	23327	524
2032	25258	25191	54749	15	884	24119	534
2033	26085	25871	56610	15	908	24938	545
2034	26939	26570	58538	16	932	25788	556
2035	27820	27288	60536	16	957	26668	567
2036	28548	27877	62101	17	978	27357	576
2037	29295	28480	63708	17	999	28065	585
2038	30061	29095	65357	18	1021	28792	594
2039	30847	29723	67051	18	1043	29538	603
2040	31654	30366	68790	19	1065	30304	613
2041	32212	30711	70021	19	1078	30846	620
2042	32781	31059	71274	19	1090	31398	627
2043	33360	31411	72550	20	1102	31960	635
2044	33949	31768	73849	20	1115	32533	643
2045	34547	32128	75172	20	1127	33115	651
2046	35157	32492	76518	21	1140	33708	658
2047	35777	32861	77890	21	1153	34313	665
2048	36409	33234	79287	21	1166	34928	672
2049	37051	33611	80709	22	1179	35555	679
2050	37705	33992	82156	22	1193	36192	686

Year	Rail Pax	Bus Pax	Car Pax	Rail (No.)	Bus (No.)	Car (No.)	Truck (No.)
2051	38370	34377	83630	22	1206	36841	693
2052	39048	34767	85131	23	1220	37503	700
2053	39738	35161	86659	23	1234	38176	707
2054	40440	35559	88216	24	1248	38862	714
2055	41147	35968	89873	24	1262	39592	721
2056	41866	36381	91561	25	1277	40335	728
2057	42598	36800	93281	25	1291	41093	735
2058	43344	37223	95034	25	1306	41865	742
2059	44103	37651	96821	26	1321	42652	749
2060	44875	38084	98643	26	1336	43455	756
2061	45661	38522	100500	27	1352	44273	763
2062	46461	38965	102392	27	1367	45107	770
2063	47274	39414	104320	28	1383	45956	777
2064	48102	39867	106285	28	1399	46822	784
2065	48944	40326	108287	29	1415	47704	791
2066	49801	40790	110329	29	1431	48603	798
2067	50672	41259	112409	30	1448	49519	805
2068	51559	41733	114528	30	1464	50453	812
2069	52461	42213	116689	31	1481	51405	819
2070	53379	42699	118891	31	1498	52375	826
2071	54313	43190	121135	32	1515	53363	833
2072	55264	43686	123422	32	1533	54371	840
2073	56232	44188	125753	33	1550	55398	847
2074	57216	44696	128129	34	1568	56444	854

The average lead, or the trip length for vehicles were estimated from travel characteristics analysed from traffic surveys. The average trip length is: for car – 156 Km, Bus – 185 Km, Train – 202 Km and the weighted average is 200Km.

The above values are considered for further analysis.

19.5.2 Time Savings

In order to work out time savings, the speeds for different vehicles have been calculated from surveys. The SilverLine speeds were determined from simulation done as part of operation plan. The time savings have been worked out as the difference of

travel time under "with and "without" project situations. The value of time saving has estimated,

- For the diverted passengers by using the proposed SilverLine system;
- For the non-diverted passengers in the form of reduced congestion due to the diverted SilverLine traffic

The savings of travel time of passengers traveling by the SilverLine instead of by road are calculated as the product of the number of passengers traveled daily and the time saved on the average passenger trip lead on the corridor.

The average Value of Time per person is arrived based on secondary data as provided in Table 19-7.

Table 19-7: Vehicle Category wise Passenger Travel Time (2018) - Urban Condition

Vehicle Type	Time value (Rs / Hour), 2019-20*
Bus	117
Car	167
Indian Railways	117
Others	117

Source:

1. Approach for Economic and Operation Assessment for Identified Urban Roads and Transportation Sub-projects, Working Paper No.: WP-05, Comprehensive Transportation Study for Chennai Metropolitan Area, May 2008

2. Escalated to 2019-20 with 10% annual growth.

Passenger time saving per annum for SilverLine is then calculated as the product of daily passengers carried, time saved on average lead on an annual basis and the value of time of SilverLine passengers.

19.5.3 Value of Vehicle Operating Cost (VOC) Savings

Value for vehicle operating cost (VOC) saving has been estimated,

- For the diverted passengers by using the proposed SilverLine system;
- And also for business as usual scenario, without SilverLine

The VOC for the existing mode is estimated based on the IRC SP 30-2009, and assumed Roughness index is 6000, R.F index of 30 and on an average 2 Lane road. The adopted VOC is provided in Table 19-8.

Table 19-8: VOC for existing mdoes

Sl.No.	Mode	VOC (in Rs.)
1	Car	8.78
2	Bus	38.33
3	MAV	24.34
4	Rail*	1821

Source: IRC SP 30-2009

* VOC for rail is estimated based on the following assumption;

Table 19-9: Vehicle operating cost for Indian Railways

Operating Expenditure Indian Railways in FY 17	160,4700	Million
Expenditure on Passenger	70%	
Operating Expenditure on Passenger traffic Indian Railways in FY 17	112,3290	Million
Total Passenger Km	1,004,418	Million Km
Train Operating Cost Per Km/ passenger	1.12	INR
No of Passengers Carried in 1 coach	74	No
No of Coaches per Train	22	No
Capacity of a train	1628	No
Train Operating Cost	1821	INR/ Km

Based on the above VOC, the savings were estimated.

19.5.4 Environmental Benefits

Fewer vehicles and the decongestion for the residual traffic on influence area roads due to SilverLine could lead to reduced air pollution. An estimate of the pollution reduction by a vehicle in this context could be obtained by multiplying the distance saved by the relevant emission coefficient for different pollutants for each category of vehicle. The emission coefficients for different vehicles are given in the table below. Estimates of reduction in distance traveled every day due to the lesser vehicles on the road is estimated by assuming average vehicle travel of 157 km for cars, and 185 Km for buses. The monetary value of these pollution loads is estimated using the estimates of prices of pollutants provided in '*Appraisal Guidelines for Metro Rail Projects Proposals, 2017, MOH&UA, GOI*' and specified in Table 19-10.

Table 19-10: Volume of pollutants emitted (gram per km) for different modes

Mode	CO	HC	NOX	PM	CO2
Cars	1.39	0.15	0.12	0.02	139.52
Bus	3.72	0.16	6.53	0.24	787.72
Treatment Cost (Rs./Ton)	100000	100000	100000	100000	500

Units in g/Km

Source: Appraisal Guidelines for Metro Rail Projects Proposals, 2017, MOH&UA, GOI

19.5.5 Accident cost Saving

The savings due to reduction in accident cost has been estimated based on the reduction in total vehicles. The cost of accidents, cost of person injury and cost of damages to vehicle is assumed based on the cost provided in Table 19-11.

Table 19-11: Unit Cost of Accidents

Details	Cost (Rs.) in 2004	Cost (Rs.) in 2019-20
Cost of Fatal Accident	437342	9,01,194
Cost of person injury	64256	1,32,407
Cost of damage to vehicles	29,911	61,636

Source: Appraisal Guidelines for Metro Rail Projects Proposals, 2017, MOH&UA, GOI

Note: 2004 costs are updated using average inflation rate

19.5.6 Reduced Road Infrastructure Costs

SilverLine will result in reduced road infrastructure costs due to:

- Reduction in annual maintenance cost
- Reduction in the road capacity improvement cost.

The cost of construction of 2 lane, (one lane on each side) on the National Highway and MC Road (State Highway) and also need for construction of super expressway from Trivandrum to Kasargod is considered as infrastructure and road maintenance saving under this section.

19.5.7 Summary of Economic Benefits

Above project economic benefits are estimated on annual basis for the selected alignment for corridor proposed in the technical section. Based on projected SilverLine traffic for the selected option, in terms of daily passengers and passenger km, the benefits are estimated and presented in Table 19-12. Average trip length by SilverLine

is estimated to be 200 Km. Considering the assigned traffic to SilverLine, its trip length, the modes from which these SilverLine trips were diverted etc., the travel scenario under (i) without project and (ii) with project scenario including distribution by different modes were developed. This was used as the inputs for estimating all the project benefits discussed above.

Table 19-12: Summary of Economic Cost

Year	Travel Time Saving	VOC Savings	GHG Savings	Accident Cost Saving	Infra Cost Savings	Total
						(INR in Crores)
2019	0	0	0	0	0	0
2020	0	0	0	0	0	0
2021	0	0	0	0	4200	4200
2022	0	0	0	0	4200	4200
2023	0	0	0	0	4200	4200
2024	0	0	0	0	4250	4250
2025	6471	1616	67	1.54	4275	12431
2026	6746	1687	70	1.61	75	8580
2027	7034	1761	72	1.68	75	8944
2028	7332	1838	74	1.75	75	9321
2029	7644	1919	76	1.82	75	9716
2030	7970	2003	78	1.90	75	10128
2031	8217	2054	80	1.97	100	10452
2032	8472	2122	81	2.03	100	10777
2033	8736	2193	83	2.10	100	11114
2034	9008	2266	85	2.17	100	11461
2035	9289	2341	87	2.24	100	11819
2036	9516	2401	88	2.29	100	12108
2037	9749	2463	89	2.35	100	12403
2038	9987	2525	91	2.41	100	12706
2039	10231	2590	92	2.47	100	13016
2040	10482	2617	94	2.54	100	13296
2041	10647	2663	95	2.58	125	13533
2042	10814	2710	96	2.62	125	13748
2043	10985	2758	97	2.67	125	13967

Year	Travel Time Saving	VOC Savings	GHG Savings	Accident Cost Saving	Infra Cost Savings	Total
						(INR in Crores)
2044	11158	2806	98	2.72	125	14190
2045	11334	2855	100	2.76	125	14416
2046	11513	2905	101	2.81	125	14646
2047	11694	2956	102	2.86	125	14880
2048	11879	3007	103	2.91	125	15117
2049	12067	3059	104	2.96	125	15359
2050	12258	3112	106	3.01	125	15604
2051	12452	3143	107	3.06	125	15830
2052	12650	3202	108	3.11	125	16088
2053	12851	3253	109	3.17	138	16354
2054	13055	3305	111	3.22	138	16612
2055	13267	3360	112	3.27	138	16880
2056	13482	3416	114	3.32	138	17152
2057	13701	3473	115	3.37	138	17430
2058	13923	3531	117	3.42	138	17712
2059	14150	3590	118	3.47	138	17999
2060	14380	3651	120	3.52	138	18292
2061	14615	3712	121	3.57	138	18589
2062	14853	3775	123	3.63	138	18892
2063	15096	3839	125	3.68	138	19200
2064	15342	3904	126	3.73	138	19513
2065	15593	3970	128	3.78	138	19832
2066	15848	4038	130	3.83	150	20169
2067	16108	4106	131	3.88	150	20499
2068	16372	4176	133	3.93	150	20835
2069	16640	4248	135	3.98	150	21177
2070	16913	4320	137	4.04	150	21525
2071	17191	4395	139	4.09	150	21878
2072	17474	4470	141	4.14	150	22239
2073	17761	4547	143	4.19	150	22605

Year	Travel Time Saving	VOC Savings	GHG Savings	Accident Cost Saving	Infra Cost Savings	Total
						(INR in Crores)
2074	18053	4625	145	4.24	150	22978
2075	18351	4705	147	4.29	150	23357

19.6 ECONOMIC ANALYSIS – EIRR & ENPV

For deriving the values of economic indicators (EIRR, ENPV), cost and benefit stream for the system has been constructed in terms of economic values..

The acceptable EIRR rate for rail projects of 14% has been considered as the social cost of capital.

The ENPV, EIRR calculated in Exhibit - I on the cost and benefit streams for SilverLine Project for 50 year period are summarized in Table 19-13.

Table 19-13: EIRR & NPV for 50 years

EIRR	24.04%
ENPV@14% (INR in Crores)	19,020

Also, the ENPV, EIRR calculated in Exhibit - II on the cost and benefit streams for SilverLine Project for 30 year period are summarized in Table 19-14.

Table 19-14: EIRR & NPV for 30 years

EIRR	23.99%
ENPV@14% (INR in Crores)	17,965

19.7 SENSITIVITY ANALYSIS

The sensitivity analysis has been carried out to see the impact of change in critical parameters in the range of 5% to 15% on EIRR.

The results of the sensitivity analysis for the SilverLine Project over 50 year period are summarized in Table 19-15.

Table 19-15: Sensitivity Analysis for 50 year period

Sensitivity Analysis	EIRR			ENPV@14% (INR in Crores)		
Scenario	**5%**	**10%**	**15%**	**5%**	**10%**	**15%**
Increase in Project Costs	22.81%	21.72%	20.74%	17,695.78	16,371.99	15,048.20

Sensitivity Analysis	EIRR			ENPV@14% (INR in Crores)		
Increase in Maintenance Costs	23.96%	23.88%	23.80%	18,851.83	18,684.08	18,516.34
Reduction in benefits	22.66%	21.31%	19.98%	16,543.50	14,067.43	11,591.36
Increase on Capital Cost & Reduction in benefits	21.52%	19.32%	17.36%	15,219.71	11,419.85	7,619.99

Further, the results of the sensitivity analysis for the SilverLine Project over 30 year period are summarized in Table 19-16..

Table 19-16: Sensitivity Analysis for 30 year period

Sensitivity Analysis	EIRR			ENPV@14% (INR in Crores)		
Scenario	**5%**	**10%**	**15%**	**5%**	**10%**	**15%**
Increase in Project Costs	22.76%	21.65%	20.66%	16,643.59	15,322.53	14,001.47
Increase in Maintenance Costs	23.91%	23.83%	23.75%	17,800.68	17,636.71	17,472.74
Reduction in benefits	22.60%	21.24%	19.88%	15,549.82	13,134.98	10,720.15
Increase on Capital Cost & Reduction in benefits	21.45%	19.21%	17.20%	14,228.76	10,492.86	6,756.97

19.8 OUTCOME ON ECONOMIC VIABILITY

The project has EIRR of 24.04% over 50 year period and 23.99% over 30 year period respectively, indicating that the benefits to the society are more than the social cost of capital of 14%. The sensitivity analysis confirms that even in adverse outcomes, the project shall be beneficial.

It also meets the acceptable norm and thus this the project is economically viable and may be implemented.

19.9 FINANCIAL ANALYSIS

19.9.1 Introduction

The financial analysis is carried out for both 30 year and 50 years operation period considering the following :

- Base Period (March 2020)
- Construction period (FY 20-21 to FY 24-25)
- Project opening for traffic (FY 25-26)
- Project operating period : Realistic Scenario : (FY 25-26 to FY 74-75), Conservative Scenario : (FY 25-26 to FY 54-55)

The SilverLine Project from Thiruvananthapuram to Kasaragod is proposed to be constructed at an estimated cost of Rs. 55,053.83 Crores with all taxes & land cost at March 2020 price levels. The total cost of land acquisition including structures amounts to INR 11,535.30 Crores. A Joint Development agreement for land amounting to INR 1,525.08 crores representing 25% of the value of private land is proposed with the land owners which is included in the above land cost. Accordingly, the Completion cost of the project is indicated in Table 19-17.

Table 19-17: Project Completion Cost

Sl. No.	Name of Corridor	Distance (KMs)	Estimated cost Excluding taxes at March 2020 prices	Estimated cost with Central taxes at March 2020 prices	Estimated cost with all taxes & land cost at March 2020 prices	Estimated completion cost with all taxes, land cost, Escalation & IDC
						(INR in Crores)
1	Thiruvananthapuram to Kasaragod	529.45	49,918.70	52.607.50	55,053.83	63.940.67

19.9.2 Investment towards Rolling Stock and Completion Cost

For the purpose of calculating the Financial Internal Rate of Return (FIRR), the completion cost with central and state taxes has been calculated by taking escalation factor @5% per annum from March 2020 price levels.

The initial Investment in Rolling Stock shall be for 261 cars and shall be progressively increased in subsequent years to cater to the increased traffic demand. Thus, additional rolling stock requirement has been estimated at 36 cars in FY 2029-30, 120 cars in FY 2041-42 and 75 cars in FY 2052-53, costs of which has been considered the analysis.

The project is scheduled to commence in FY 2020-21 and is scheduled to be completed by FY 2024- 2025 with Revenue Opening Date (ROD) scheduled on 01.04.2025..

The total completion costs before and after escalation without the land on joint development are shown in Table 19-18 to Table 19-25.

Table 19-18: Year Wise Cost Allocation without Escalation of Basic Cost

	FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	Total
							(INR in Crores)
Land - Excluding JDA	1,501.53	5,005.11	3,503.58	-	-	-	10,010.23
R&R and ESMP	-	519.00	865.00	346.00	-	-	1,730.00
Design	67.25	403.52	201.76	-	-	-	672.54
PMC	-	201.76	403.52	403.52	201.76	134.51	1,345.08
Contingency	-	-	100.88	201.76	302.64	403.52	1,008.81
Civil	-	3,582.14	7,164.28	7,164.28	4,776.19	1,194.05	23,880.93
Rolling Stock	-	-	698.40	1,396.80	1,862.40	698.40	4,656.00
Ticketing & Fare Collection System	-	-	-	37.40	37.40	18.70	93.50
Signalling & Train Control, Communication, Traction & other Systems	-	-	-	1,928.62	1,928.62	964.31	4,821.54
Miscellaneous	-	-	-	70.00	70.00	35.00	175.00
Total	1,568.79	9,711.54	12,937.42	11,548.38	9,179.01	3,448.49	48,393.62

Table 19-19: Year Wise Cost Allocation without Escalation of Central Taxes

	FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	Total
							(INR in Crores)
Land - Excluding JDA	-	-	-	-	-	-	-
R&R and ESMP	-	-	-	-	-	-	-
Design	6.05	36.32	18.16	-	-	-	60.53
PMC	-	18.16	36.32	36.32	18.16	12.11	121.06
Contingency	-	-	9.08	18.16	27.24	36.32	90.79
Civil	-	234.73	469.45	469.45	312.97	78.24	1,564.85
Rolling Stock	-	-	56.57	113.15	150.86	56.57	377.15
Ticketing & Fare Collection System	-	-	-	4.26	4.26	2.13	10.66
Signalling & Train Control, Communication, Traction & other Systems	-	-	-	180.41	180.41	90.20	451.02

	FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	Total
							(INR in Crores)
Miscellaneous	-	-	-	5.10	5.10	2.55	12.75
Total	6.05	289.20	589.58	826.85	699.00	278.12	2,688.81

Table 19-20: Year Wise Cost Allocation without Escalation of State Taxes

	FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	Total
							(INR in Crores)
Land - Excluding JDA	-	-	-	-	-	-	-
R&R and ESMP	-	-	-	-	-	-	-
Design	6.05	36.32	18.16	-	-	-	60.53
PMC	-	18.16	36.32	36.32	18.16	12.11	121.06
Contingency	-	-	9.08	18.16	27.24	36.32	90.79
Civil	-	222.62	445.24	445.24	296.83	74.21	1,484.14
Rolling Stock	-	-	47.60	95.21	126.94	47.60	317.36
Ticketing & Fare Collection System	-	-	-	3.03	3.03	1.51	7.57
Signalling & Train Control, Communication, Traction & other Systems	-	-	-	140.85	140.85	70.43	352.13
Miscellaneous	-	-	-	5.10	5.10	2.55	12.75
Total	6.05	277.10	556.40	743.91	618.15	244.72	2,446.33

Table 19-21: Escalation Factors

FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26
1.0250	1.0750	1.1275	1.1826	1.2405	1.3013

Table 19-22: Year Wise Cost Allocation including Escalation of Basic Cost

	FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	Total
							(INR in Crores)
Land - Excluding JDA	1,539.07	5,380.50	3,950.29	-	-	-	10,869.85
R&R and ESMP	-	557.93	975.29	409.19	-	-	1,942.40
Design	68.94	433.79	227.49	-	-	-	730.21
PMC	-	216.89	454.97	477.22	250.29	175.03	1,574.40

	FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	Total
							(INR in Crores)
Contingency	-	-	113.74	238.61	375.43	525.10	1,252.88
Civil	-	3,850.80	8,077.72	8,472.65	5,924.89	1,553.79	27,879.86
Rolling Stock	-	-	787.45	1,651.89	2,310.32	908.82	5,658.47
Ticketing & Fare Collection System	-	-	-	44.23	46.39	24.33	114.96
Signalling & Train Control, Communication, Traction & other Systems	-	-	-	2,280.83	2,392.46	1,254.84	5,928.13
Miscellaneous	-	-	-	82.78	86.84	45.54	215.16
Total	1,608.01	10,439.90	14,586.94	13,657.40	11,386.61	4,487.45	56,166.32
Escalation on Basic Cost	**39.22**	**728.37**	**1,649.52**	**2,109.02**	**2,207.61**	**1,038.97**	**7,772.70**

Table 19-23: Year-wise Cost Allocation including Escalation of Central Taxes

	FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	Total
							(INR in Crores)
Land - Excluding JDA	-	-	-	-	-	-	-
R&R and ESMP	-	-	-	-	-	-	-
Design	6.20	39.04	20.47	-	-	-	65.72
PMC	-	19.52	40.95	42.95	22.53	15.75	141.70
Contingency	-	-	10.24	21.47	33.79	47.26	112.76
Civil	-	252.33	529.31	555.19	388.24	101.82	1,826.89
Rolling Stock	-	-	63.79	133.81	187.14	73.62	458.36
Ticketing & Fare Collection System	-	-	-	5.04	5.29	2.77	13.10
Signalling & Train Control, Communication, Traction & other Systems	-	-	-	213.36	223.80	117.38	554.53
Miscellaneous	-	-	-	6.03	6.33	3.32	15.68
Total	6.20	310.89	664.75	977.85	867.11	361.92	3,188.73
Escalation on Central taxes	**0.15**	**21.69**	**75.17**	**151.00**	**168.11**	**83.79**	**499.92**

Table 19-24: Year Wise Cost Allocation including Escalation of State Taxes

	FY 20-21	FY 21-22	FY 22-23	FY 23-24	FY 24-25	FY 25-26	Total
							(INR in Crores)
Land - Excluding JDA	-	-	-	-	-	-	-
R&R and ESMP	-	-	-	-	-	-	-
Design	6.20	39.04	20.47	-	-	-	65.72
PMC	-	19.52	40.95	42.95	22.53	15.75	141.70
Contingency	-	-	10.24	21.47	33.79	47.26	112.76
Civil	-	239.32	502.01	526.55	368.22	96.56	1,732.67
Rolling Stock	-	-	53.67	112.59	157.47	61.95	385.69
Ticketing & Fare Collection System	-	-	-	3.58	3.76	1.97	9.31
Signalling & Train Control, Communication, Traction & other Systems	-	-	-	166.58	174.73	91.64	432.95
Miscellaneous	-	-	-	6.03	6.33	3.32	15.68
Total	6.20	297.88	627.34	879.76	766.82	318.45	2,896.46
Escalation on State Taxes	**0.15**	**20.78**	**70.94**	**135.86**	**148.67**	**73.73**	**450.13**

Table 19-25: Year Wise Capex Phasing

	FY 21	FY 22	FY 23	FY 24	FY 25	FY 26	Total
							(INR in Crores)
Yearly Outflows on CAPEX	**1,620.24**	**11,048.67**	**15,879.04**	**15,515.01**	**13,020.54**	**5,167.82**	**62,251.51**

19.9.3 O&M Costs

The Operation & Maintenance costs can be divided into three major parts: -

- Energy Costs
- Staff costs
- Maintenance cost which include expenditure towards upkeep and maintenance of the system and consumables.

19.9.3.1 Energy costs

Energy demand for the project will be sourced from solar power from private developer on a RESCO model and the balance solar power requirement shall be sourced from Kerala State Electricity Board.

The solar power is assumed to be made available at INR 3.50 per unit (at prevailing market rates) without any escalation for 50% of the solar power supplied directly. The balance 50% solar power shall be supplied through the KSEBL grid from a third party by availing open access. The following charges shall be paid to KSEBL

- Transmission charges
- Wheeling charges
- Cross subsidy charges
- Transmission losses and Distribution losses
- Any other charges approved by the commission

The prevailing aggregate transmission and wheeling charges for providing supply at Extra High Tension (EHT) is 0.39/ unit and losses is 3.95% (refer tariff order), which shall be subjected to an escalation of 5% per annum. The cross-subsidy charges mentioned for Indian Railway is Rs 1.26/unit.

The remaining requirement of renewable power is to be directly purchased from KSEBL at a cost INR 6.50 per unit subjected to an annual escalation of 3% p.a.

It is proposed that K-Rail takes necessary steps to Govt of Kerala, KSEBL and KSERC to fix the tariff for SilverLine Project at “No Profit No loss basis”.

Accordingly, the energy costs based on the requirement are detailed in Table 19-26.

Table 19-26: Details of Energy cost

Energy cost (INR in Crores)						
	Year	Total Energy consumption (kwh)	Solar energy cost from K-RAIL (Fixed charge)	Solar energy Cost(fixed + varying from K-RAIL	Renewable energy Cost from KSEBL	Total Energy Cost (Including Escalation)
1	2025-2026	278807724	17	27.65	119	**163**
2	2026-2027	278807724	17	27.89	122	**167**
3	2027-2028	278807724	17	28.14	126	**171**
4	2028-2029	278807724	17	28.40	130	**175**
5	2029-2030	319472964	17	28.68	163	**209**
6	2030-2031	319472964	17	28.97	168	**214**
7	2031-2032	321272964	21	36.60	156	**214**
8	2032-2033	321272964	21	37.00	161	**219**
9	2033-2034	321272964	21	37.42	166	**224**
10	2034-2035	321272964	21	37.87	171	**230**
11	2035-2036	321272964	21	38.33	176	**235**
12	2036-2037	321272964	21	38.82	181	**241**

Energy cost (INR in Crores)						
	Year	Total Energy consumption (kwh)	Solar energy cost from K-RAIL (Fixed charge)	Solar energy Cost(fixed + varying from K-RAIL	Renewable energy Cost from KSEBL	Total Energy Cost (Including Escalation)
13	2037-2038	321272964	21	39.34	187	**247**
14	2038-2039	321272964	21	39.87	192	**253**
15	2039-2040	321272964	21	40.44	198	**259**
16	2040-2041	321272964	21	41.03	204	**266**
17	2041-2042	427155264	21	41.66	320	**383**
18	2042-2043	427155264	21	42.31	330	**393**
19	2043-2044	427155264	21	43.00	340	**404**
20	2044-2045	427155264	21	43.72	350	**415**
21	2045-2046	427155264	21	44.48	361	**426**
22	2046-2047	427155264	21	45.28	371	**438**
23	2047-2048	427155264	21	46.11	383	**450**
24	2048-2049	427155264	21	46.99	394	**462**
25	2049-2050	427155264	21	47.91	406	**475**
26	2050-2051	427155264	21	48.88	418	**488**
27	2051-2052	427155264	21	49.89	431	**501**
28	2052-2053	496753344	21	50.96	544	**616**
29	2053-2054	496753344	21	52.08	560	**633**
30	2054-2055	496753344	21	53.26	577	**651**
31	2055-2056	496753344	21	54.49	594	**670**
32	2056-2057	496753344	21	55.79	612	**689**
33	2057-2058	496753344	21	57.15	631	**709**
34	2058-2059	496753344	21	58.58	650	**729**
35	2059-2060	496753344	21	60.08	669	**750**
36	2060-2061	496753344	21	61.66	689	**772**
37	2061-2062	496753344	21	63.31	710	**794**
38	2062-2063	571525524	21	65.05	876	**962**
39	2063-2064	571525524	21	66.87	902	**990**
40	2064-2065	571525524	21	68.79	929	**1019**
41	2065-2066	571525524	21	70.80	957	**1049**
42	2066-2067	571525524	21	72.91	986	**1080**
43	2067-2068	571525524	21	75.13	1016	**1112**

Energy cost (INR in Crores)							
	Year	Total Energy consumption (kwh)	Solar energy cost from K-RAIL (Fixed charge)	Solar energy Cost(fixed + varying from K-RAIL	Renewable energy Cost from KSEBL	Total Energy Cost (Including Escalation)
44	2068-2069	571525524	21	77.46	1046	**1145**
45	2069-2070	571525524	21	79.90	1078	**1178**
46	2070-2071	571525524	21	82.47	1110	**1213**
47	2071-2072	571525524	21	85.17	1143	**1249**
48	2072-2073	659410524	21	88.00	1407	**1516**
49	2073-2074	659410524	21	90.97	1449	**1561**
50	2074-2075	659410524	21	94.09	1492	**1607**

19.9.3.2 Employee Costs

The Operations & Maintenance staff shall consist of 3384 Inhouse employees and 1516 outsourced employees resulting in an employee requirement of 6.38 employees and 2.86 employees per kilometer as per Table 19-27.

Table 19-27: Manpower Requirement

Department	No of Units	In House	Outsource	Total Staff
OCC	1	54	10	64
Training Centre	1	20	2	22
SHE	1	21	0	21
Station	10	409	792	1201
Train Crew	1	427	10	437
Rolling Stock Maintenance	2	399	116	515
Depot Maintenance	2	81	10	91
DCC	2	19	0	19
Civil & Track Maintenance	6	840	360	1200
Traction & MEP Maintenance	4	480	120	600
S&T Maintenance	4	384	96	480
HQ	1	250	0	250
TOTAL		**3384**	**1516**	**4900**
Per KM (Per 529.45 KM)		**6.39**	**2.86**	**9.25**

The cost of outsourced employees is included in the maintenance cost and only the cost of in-house employees has been considered under employee costs. The average salary

of an inhouse employee is estimated at INR 800,000 per annum resulting in employee cost of INR 271 crores at March 2020 levels.

The employee costs are escalated at 5 % per annum till FY 2024- 25 and 8% per annum from FY 2025-26.

19.9.3.3 Maintenance Costs

The maintenance expenses has been calculated at INR 1.02 crores per kilometer for the initial 10 years of operation and INR 1.31 crores per kilometer from the 11th year of operations as per Table 19-28.

The maintenance costs are escalated at 5 % per annum.

Table 19-28: Maintenance Costs

<table>
<tr><th>SL No</th><th>Sub System</th><th>Maintenance Cost Annually in the initial 10 Years</th><th>Maintenance Cost Annually after 10 Years</th><th>Cr/km/year in initial 10 years</th><th>Cr/km/year after10 years</th><th>Remark</th></tr>
<tr><th colspan="7">(INR in Crores)</th></tr>
<tr><td>1</td><td>Rolling Stock</td><td>130</td><td>282</td><td rowspan="5">1.02</td><td rowspan="5">1.31</td><td>282 Cr per year for total maintenance. Considered 45% of this cost for initial 10 years</td></tr>
<tr><td>2</td><td>S&T</td><td rowspan="2">152</td><td rowspan="2">152</td><td rowspan="2">0.21 Cr/km is considered</td></tr>
<tr><td>3</td><td>Traction & Power Supply</td></tr>
<tr><td>4</td><td>Track</td><td rowspan="2">260</td><td rowspan="2">260</td><td rowspan="2">0.43 Cr/km is considered</td></tr>
<tr><td>5</td><td>Civil Infrastructure</td></tr>
<tr><td colspan="2">Total</td><td>542</td><td>694</td></tr>
</table>

Accordingly, the O&M expenditure is summarised in Table 19-29.

Table 19-29: Year Wise O & M Cost

Year		Energy Cost	Staff Salary	Maintenance	Total O & M Expenditure
					(INR in Crores)
2025	2026	163.27	373.18	726.33	1262.78
2026	2027	167.08	403.03	762.65	1332.76
2027	2028	171.00	435.28	800.78	1407.06
2028	2029	175.05	470.10	840.82	1485.96

Year		Energy Cost	Staff Salary	Maintenance	Total O & M Expenditure
					(INR in Crores)
2029	2030	208.97	507.70	882.86	1599.54
2030	2031	214.17	548.32	927.00	1689.49
2031	2032	213.82	592.19	973.35	1779.36
2032	2033	218.90	639.56	1022.02	1880.49
2033	2034	224.15	690.73	1073.12	1988.00
2034	2035	229.57	745.98	1126.78	2102.33
2035	2036	235.15	805.66	1514.91	2555.73
2036	2037	240.92	870.12	1590.66	2701.70
2037	2038	246.86	939.73	1670.19	2856.78
2038	2039	253.00	1014.90	1753.70	3021.61
2039	2040	259.33	1096.10	1841.39	3196.81
2040	2041	265.86	1183.78	1933.46	3383.10
2041	2042	383.04	1278.49	2030.13	3691.66
2042	2043	393.30	1380.77	2131.64	3905.71
2043	2044	403.89	1491.23	2238.22	4133.34
2044	2045	414.81	1610.53	2350.13	4375.47
2045	2046	426.07	1739.37	2467.64	4633.08
2046	2047	437.69	1878.52	2591.02	4907.22
2047	2048	449.66	2028.80	2720.57	5199.03
2048	2049	462.02	2191.10	2856.60	5509.72
2049	2050	474.76	2366.39	2999.43	5840.58
2050	2051	487.90	2555.70	3149.40	6193.00
2051	2052	501.46	2760.16	3306.87	6568.49
2052	2053	615.93	2980.97	3472.21	7069.11
2053	2054	633.37	3219.45	3645.82	7498.64
2054	2055	651.36	3477.00	3828.11	7956.47
2055	2056	669.90	3755.16	4019.52	8444.59
2056	2057	689.03	4055.58	4220.50	8965.11
2057	2058	708.76	4380.02	4431.52	9520.31
2058	2059	729.11	4730.43	4653.10	10112.63
2059	2060	750.10	5108.86	4885.75	10744.71
2060	2061	771.74	5517.57	5130.04	11419.35

Year		Energy Cost	Staff Salary	Maintenance	Total O & M Expenditure
					(INR in Crores)
2061	2062	794.07	5958.97	5386.54	12139.58
2062	2063	962.19	6435.69	5655.87	13053.75
2063	2064	990.30	6950.55	5938.66	13879.50
2064	2065	1019.28	7506.59	6235.60	14761.47
2065	2066	1049.18	8107.12	6547.38	15703.67
2066	2067	1080.01	8755.69	6874.74	16710.45
2067	2068	1111.81	9456.14	7218.48	17786.44
2068	2069	1144.61	10212.63	7579.41	18936.65
2069	2070	1178.44	11029.64	7958.38	20166.46
2070	2071	1213.34	11912.02	8356.29	21481.65
2071	2072	1249.33	12864.98	8774.11	22888.41
2072	2073	1515.63	13894.18	9212.81	24622.62
2073	2074	1560.80	15005.71	9673.46	26239.97
2074	2075	1607.39	16206.17	10157.13	27970.68

19.9.4 Replacement Cost

The replacement costs are provided for meeting the cost of various systems on account of replacement of equipment due to wear and tear as detailed below :

19.9.4.1 Rolling Stock Replacement

The rolling stock including the additional rolling Stock shall need major expenditure on replacement of various components. The expected expenditure of the same is estimated in Table 19-30.

Table 19-30: Rolling Stock Replacement Expenditure (INR in Crores)

Year After Operation	FY	RS Replacement %- First RS Lot of 261 Cars	RS Replacement % -Second RS Lot of 36 Cars	RS Replacement % -Third RS Lot of 120 Cars	RS Replacement %- Fourth RS Lot of 90 Cars	Replacement Cost- Rolling Stock (Including Escalation)
						(INR in Crores)
11th	2035-2036	5%				449.05
16th	2040-2041	15%	5%			1,814.86
21st	2045-2046	15%	15%			2,560.08
26th	2050-2051	10%	15%			2,333.85

Year After Operation	FY	RS Replacement %- First RS Lot of 261 Cars	RS Replacement % -Second RS Lot of 36 Cars	RS Replacement % -Third RS Lot of 120 Cars	RS Replacement %- Fourth RS Lot of 90 Cars	Replacement Cost- Rolling Stock (Including Escalation)
						(INR in Crores)
28th	2052-2053			5%		457.43
31st	2055-2056	15%	10%			3,971.53
33rd	2057-2058			15%		1,751.45
36th	2060-2061		15%			760.32
38th	2062-2063			15%		2,235.34
39th	2063-2064				5%	586.78
43rd	2067-2068			10%		1,901.95
44th	2068-2069				15%	2,246.67
48th	2072-2073			15%		3,641.13
49th	2073-2074				15%	2,867.39

19.9.4.2 Signalling & Train Control, Communication and Ticketing & Fare collection System

The Signalling & Train Control System, Communication System, Ticketing & Fare collection System shall need replacement of equipment's having different life cycles at various stages. The expected expenditure of the same is estimated in Table 19-31.

Table 19-31: Replacement Expenditure

Year After Operation	FY	First Cycle Replacement	Subsequent Cycle Replacement		Total	Replacement Cost - Signalling & Train Control System, Communication System, Ticketing & Fare collection System (Including Escalation)
						(INR in Crores)
11th	2035-2036	10%			10%	524.94
16th	2040-2041	15%			15%	1,004.95
21st	2045-2046	25%	10%		35%	2,992.74
26th	2050-2051	20%			20%	2,182.62
31st	2055-2056	20%	10%	15%	45%	6,267.67
41st	2065-2066		10%	25%	35%	7,940.63
46th	2070-2071			15%	15%	4,343.35

19.9.4.3 Traction & Power Supply System

The Traction & Power supply system shall need replacement of equipment's having different life cycles at various stages. The expected expenditure on the same is estimated in Table 19-32.

Table 19-32: Traction & Power Supply System Replacement Expenditure

Year After Operation	FY	First Replacement	Subsequent Cycle Replacement		Total	Replacement Cost - Traction System (Including Escalation)
						(INR in Crores)
17th	2041-2042	10%			10%	665.85
22nd	2046-2047	10%			10%	849.81
26th	2050-2051	10%			10%	1,032,94
31st	2055-2056	20%	10%		30%	3,954.98
36th	2060-2061	30%			30%	5,047.67
42nd	2066-2067			10%	10%	2,254.79
46th	2070-2071		10%		10%	2,740.71

19.9.4.4 Permanent Way System

The Permanent Way System shall need major replacement during each year. The expected expenditure on the same is estimated in Table 19-33

Table 19-33: Permanent Way System Replacement Expenditure

Year After Operation	FY	% Expenditure Every Year	Replacement Cost – Permanent Way Including Escalation
			(INR in Crores)
1st	2025-2026	0%	-
2nd	2026-2027	2%	79.21
3rd	2027-2028	2%	83.17
4th	2028-2029	2%	87.33
5th	2029-2030	2%	91.70
6th	2030-2031	2%	102.90
7th	2031-2032	2%	108.05
8th	2032-2033	2%	113.45
9th	2033-2034	2%	119.12
10th	2034-2035	2%	160.19

Year After Operation	FY	% Expenditure Every Year	Replacement Cost – Permanent Way Including Escalation
			(INR in Crores)
11th	2035-2036	4%	291.09
12th	2036-2037	4%	305.64
13th	2037-2038	4%	320.92
14th	2038-2039	4%	346.75
15th	2039-2040	4%	364.09
16th	2040-2041	2%	225.45
17th	2041-2042	2%	236.73
18th	2042-2043	2%	248.56
19th	2043-2044	2%	260.99
20th	2044-2045	2%	274.04
21st	2045-2046	2%	287.74
22nd	2046-2047	2%	302.13
23rd	2047-2048	3%	347.58
24th	2048-2049	3%	364.96
25th	2049-2050	3%	383.21
26th	2050-2051	4%	657.84
27th	2051-2052	8%	1,414.99
28th	2052-2053	8%	1,485.74
29th	2053-2054	8%	1,560.03
30th	2054-2055	8%	1,638.03
31st	2055-2056	8%	1,719.93
32nd	2056-2057	2%	436.50
33rd	2057-2058	2%	458.33
34th	2058-2059	2%	481.25
35th	2059-2060	2%	505.31
36th	2060-2061	10%	2,704.89
37th	2061-2062	10%	2,840.13
38th	2062-2063	10%	2,982.14
39th	2063-2064	10%	3,131.25

Year After Operation	FY	% Expenditure Every Year	Replacement Cost – Permanent Way Including Escalation
			(INR in Crores)
40th	2064-2065	10%	3,287.81
41st	2065-2066	2%	531.11
42nd	2066-2067	2%	724.96
43rd	2067-2068	4%	1,346.76
44th	2068-2069	4%	1,414.09
45th	2069-2070	4%	1,484.80
46th	2070-2071	4%	1,605.64
47th	2071-2072	4%	1,685.92
48th	2072-2073	2%	1,022.90
49th	2073-2074	2%	1,074.04
50th	2074-2075	1%	303.82

19.9.5 Revenue

The revenue streams for the project are detailed as under:

- Fare Box Revenue
- Non Fare Box Revenue comprising of Advertising Revenue, ATMs/ Kiosks on Stations, Property Development.
- Value Capture revenue from Transit Oriented Development.

19.9.5.1 Fare Box Revenue

The sources of Fare Box revenue are the Passenger Trip Revenues and the RORO revenue from goods traffic.

19.9.5.1.1 Fare box revenues from passenger traffic.

Based on the traffic Studies, the estimated potential passengers of the SilverLine network has been determined. Further, passenger fare of INR 2.75 per km has been determined as the optimal fare for calculation of Passenger Fare revenues.

Average Passenger trip length distribution as determined from the traffic studies is 200 km and a yearly escalation of 6% is considered on the fare.

Accordingly, the fare box revenues are detailed in Table 19-34.

Table 19-34: Passenger Fare Box Revenue

Year		Total Passengers/ Day	Average Trip Length (in Km)	Fare (in INR/Km)	Daily Revenue (INR in Crores)	Annual Fare Revenue (INR in Crores)
2025	2026	79934	200	3.90	6.24	2276
2026	2027	83376	200	4.13	6.90	2517
2027	2028	86975	200	4.38	7.62	2783
2028	2029	90738	200	4.65	8.43	3077
2029	2030	94672	200	4.92	9.32	3404
2030	2031	98788	200	5.22	10.31	3765
2031	2032	101940	200	5.53	11.28	4118
2032	2033	105198	200	5.87	12.34	4504
2033	2034	108566	200	6.22	13.50	4928
2034	2035	112047	200	6.59	14.77	5391
2035	2036	115644	200	6.99	16.16	5898
2036	2037	118526	200	7.41	17.55	6407
2037	2038	121483	200	7.85	19.07	6961
2038	2039	124513	200	8.32	20.72	7563
2039	2040	127621	200	8.82	22.51	8217
2040	2041	130810	200	9.35	24.46	8927
2041	2042	132944	200	9.91	26.35	9617
2042	2043	135114	200	10.50	28.39	10361
2043	2044	137321	200	11.13	30.58	11162
2044	2045	139566	200	11.80	32.94	12025
2045	2046	141847	200	12.51	35.49	12955
2046	2047	144167	200	13.26	38.24	13957
2047	2048	146528	200	14.06	41.20	15036
2048	2049	148930	200	14.90	44.38	16200
2049	2050	151371	200	15.79	47.82	17453
2050	2051	153853	200	16.74	51.52	18804
2051	2052	156377	200	17.75	55.50	20259
2052	2053	158946	200	18.81	59.80	21827
2053	2054	161558	200	19.94	64.43	23517
2054	2055	164215	200	21.14	69.42	25338

Year		Total Passengers/ Day	Average Trip Length (in Km)	Fare (in INR/Km)	Daily Revenue (INR in Crores)	Annual Fare Revenue (INR in Crores)
2055	2056	165246	200	22.40	74.05	27027
2056	2057	166288	200	23.75	78.98	28829
2057	2058	167336	200	25.17	84.25	30752
2058	2059	168394	200	26.68	89.87	32803
2059	2060	169460	200	28.29	95.87	34991
2060	2061	170536	200	29.98	102.26	37326
2061	2062	171623	200	31.78	109.09	39818
2062	2063	172718	200	33.69	116.37	42476
2063	2064	173823	200	35.71	124.14	45313
2064	2065	174938	200	37.85	132.44	48340
2065	2066	176062	200	40.12	141.29	51569
2066	2067	177198	200	42.53	150.73	55016
2067	2068	178343	200	45.08	160.81	58694
2068	2069	179499	200	47.79	171.56	62619
2069	2070	180667	200	50.66	183.04	66808
2070	2071	181845	200	53.69	195.28	71278
2071	2072	183033	200	56.92	208.35	76048
2072	2073	184232	200	60.33	222.30	81139
2073	2074	185443	200	63.95	237.19	86573
2074	2075	186663	200	67.79	253.07	92371

19.9.5.1.2 Fare box revenues from Roll On Roll Off freight services

Roll On Roll Off Freight traffic is another revenue segment planned for operation during the lean hours i.e. from 22:00 to 6:00 Hours.

It is estimated that the RORO operations shall generate a revenue of INR 13,536 per truck for the full trip length. RORO revenues have been calculated considering an average trip length of 392 kms and a yearly escalation of 6% is considered on the fare.

Accordingly, the RORO revenues are detailed in Table 19-35.

Table 19-35: RORO Fare Box Revenue

Year		RORO Utilisation	Average Trip Length (Km)	Fare (in INR/Km)	Daily Revenue (INR in Crores)	Annual Fare Revenue (INR in Crores)
2025	2026	457	392	36.19	0.65	237
2026	2027	468	392	38.36	0.70	257
2027	2028	479	392	40.66	0.76	279
2028	2029	480	392	43.10	0.81	296
2029	2030	480	392	45.69	0.86	314
2030	2031	480	392	48.43	0.91	333
2031	2032	480	392	51.33	0.97	353
2032	2033	480	392	54.41	1.02	374
2033	2034	480	392	57.68	1.09	396
2034	2035	480	392	61.14	1.15	420
2035	2036	480	392	64.81	1.22	445
2036	2037	480	392	68.69	1.29	472
2037	2038	480	392	72.82	1.37	500
2038	2039	480	392	77.19	1.45	530
2039	2040	480	392	81.82	1.54	562
2040	2041	480	392	86.73	1.63	596
2041	2042	480	392	91.93	1.73	631
2042	2043	480	392	97.44	1.83	669
2043	2044	480	392	103.29	1.94	709
2044	2045	480	392	109.49	2.06	752
2045	2046	480	392	116.06	2.18	797
2046	2047	480	392	123.02	2.31	845
2047	2048	480	392	130.40	2.45	896
2048	2049	480	392	138.23	2.60	949
2049	2050	480	392	146.52	2.76	1006
2050	2051	480	392	155.31	2.92	1067
2051	2052	480	392	164.63	3.10	1131
2052	2053	480	392	174.51	3.28	1198
2053	2054	480	392	184.98	3.48	1270
2054	2055	480	392	196.08	3.69	1347

Year		RORO Utilisation	Average Trip Length (Km)	Fare (in INR/Km)	Daily Revenue (INR in Crores)	Annual Fare Revenue (INR in Crores)
2055	2056	480	392	207.84	3.91	1427
2056	2057	480	392	220.31	4.15	1513
2057	2058	480	392	233.53	4.39	1604
2058	2059	480	392	247.54	4.66	1700
2059	2060	480	392	262.40	4.94	1802
2060	2061	480	392	278.14	5.23	1910
2061	2062	480	392	294.83	5.55	2025
2062	2063	480	392	312.52	5.88	2146
2063	2064	480	392	331.27	6.23	2275
2064	2065	480	392	351.15	6.61	2412
2065	2066	480	392	372.21	7.00	2556
2066	2067	480	392	394.55	7.42	2710
2067	2068	480	392	418.22	7.87	2872
2068	2069	480	392	443.31	8.34	3045
2069	2070	480	392	469.91	8.84	3227
2070	2071	480	392	498.11	9.37	3421
2071	2072	480	392	527.99	9.93	3626
2072	2073	480	392	559.67	10.53	3844
2073	2074	480	392	593.25	11.16	4074
2074	2075	480	392	628.85	11.83	4319

19.9.5.2 Non- Fare box source of Revenue

Non-fare box revenues could be generated from commercial development and advertisement at station buildings, advertisement on trains and tickets, advertisements within stations and parking lots, film shootings and special events on trains & Station premises.

The major sources of non-fare revenues for the SilverLine are detailed below:

- **Advertisement revenues from Stations & Trains** – Advertisement rights from advertisement opportunities in the platforms, concourse area, station buildings and parking areas is expected to generate a revenue of INR 0.50 crores per station resulting in total revenue of INR 5 crores per annum from 10 stations offering this scope with an annual escalation of 5% of revenues. In addition, the advertisement

branding on the trains is expected to generate a revenue of 13.50 Lakh per train resulting in a total revenue of 3.92 Crore per annum with an annual escalation of 5% of revenues.

- **Revenue from Stations Semi-Naming Rights** – Advertisement revenue can be generated by selling Station Semi- naming rights to various commercial brands in the city. This is expected to generate a revenue of INR 1.00 crore per station resulting in total revenue of INR 10 crores per annum from 10 stations offering this scope. Further, an annual escalation of 5% shall be applicable.
- **Rentals from Kiosks & ATM counters in Concourse areas and station building** – Revenue can be generated by leasing of space for 10 numbers Kiosk & ATM centers in each station at a rental value of INR 10,000 per month. Accordingly, it is estimated that revenue from 10 stations shall amount to INR 1.2 crores per annum. Further, a yearly escalation of 5% shall be applicable.
- **Property development at Stations** - Considering the high potential of property development at stations, private partnership has been considered desirable for this development to minimize the cash outflows. The private developer shall be responsible for the construction, maintenance and collection of revenues.

Based on the construction area available for Property development, the estimated construction cost of the development and the revenue potential are summarized in Table 19-36.

Table 19-36: Property Development Construction Cost and Revenue

Sl No	Station	Area of Construction (Sq ft)	Cost of Construction (INR/Sq ft)	Cost of Construction (Crores)	Rental Value (INR/Sq ft)	Annual Rental (Crores)
1	Thiruvanathapuram	2,784,912	2300	641	45.00	150.39
2	Kollam	2,755,806	1900	524	39.15	129.47
3	Chengannur	1,311,614	1900	249	39.15	61.62
4	Kottayam	3,124,254	1900	594	39.15	146.78
5	Ernakulam	2,806,429	2300	645	65.00	218.90
6	Thrissur	3,356,744	2300	772	43.50	175.22
7	Tirur	1,188,894	1900	226	39.15	55.85
8	Kozhikode	3,813,133	2300	877	39.15	179.14
9	Kannur	2,713,063	1900	515	39.15	127.46
10	Kasargod	2,358,650	1900	448	39.15	110.81
		26,213,498		5,491		1,356

An yearly escalation of 5% shall be applicable in respect of the revenues. The yearly maintenance expenditure has been considered as 12.5% of the escalated revenues (which is about INR 5.40 per square feet / month in FY 2025).

As the developer shall expect at least a return of about 16% on the investment over a 30-year period, it is anticipated that about 15% of the total annual revenues shall be available to the SilverLine Project and the remaining shall be retained by the developer.

Accordingly. the amount of leasing income available to the SilverLine Project and to the developer are detailed in Table 19-37.

Table 19-37: Cost and Revenue Streams from Property Development

Period		Capital Outlay	Maintenance Expenditure & Fees	Annual Revenue with 100% occupancy	Occupancy	Net Annual Revenue	Cash Flow from Development	Leasing Revenues to SilverLine	Net Cash Flow to Developer
									(INR in Crores)
2022	2023	1,647.30	-				(1,647.30)		(1,647.30)
2023	2024	2,882.78	-				(2,882.78)		(2,882.78)
2024	2025	1,210.77	-				(1,210.77)		(1,210.77)
2025	2026		101.67	1,355.64	60%	813.38	711.71	122.01	589.70
2026	2027		115.65	1,423.42	65%	925.22	809.57	138.78	670.79
2027	2028		130.78	1,494.59	70%	1,046.21	915.44	156.93	758.50
2028	2029		147.12	1,569.32	75%	1,176.99	1,029.87	176.55	853.32
2029	2030		164.78	1,647.79	80%	1,318.23	1,153.45	197.73	955.72
2030	2031		183.83	1,730.18	85%	1,470.65	1,286.82	220.60	1,066.22
2031	2032		204.38	1,816.68	90%	1,635.02	1,430.64	245.25	1,185.39
2032	2033		214.60	1,907.52	90%	1,716.77	1,502.17	257.52	1,244.66
2033	2034		225.33	2,002.89	90%	1,802.61	1,577.28	270.39	1,306.89
2034	2035		236.59	2,103.04	90%	1,892.74	1,656.14	283.91	1,372.23
2035	2036		248.42	2,208.19	90%	1,987.37	1,738.95	298.11	1,440.84
2036	2037		260.84	2,318.60	90%	2,086.74	1,825.90	313.01	1,512.89
2037	2038		273.88	2,434.53	90%	2,191.08	1,917.19	328.66	1,588.53
2038	2039		287.58	2,556.26	90%	2,300.63	2,013.05	345.09	1,667.96
2039	2040		301.96	2,684.07	90%	2,415.66	2,113.71	362.35	1,751.36

Period		Capital Outlay	Maintenance Expenditure & Fees	Annual Revenue with 100% occupancy	Occupancy	Net Annual Revenue	Cash Flow from Development	Leasing Revenues to SilverLine	Net Cash Flow to Developer
									(INR in Crores)
2040	2041		317.06	2,818.27	90%	2,536.45	2,219.39	380.47	1,838.92
2041	2042		332.91	2,959.19	90%	2,663.27	2,330.36	399.49	1,930.87
2042	2043		349.55	3,107.15	90%	2,796.43	2,446.88	419.46	2,027.41
2043	2044		367.03	3,262.50	90%	2,936.25	2,569.22	440.44	2,128.78
2044	2045		385.38	3,425.63	90%	3,083.07	2,697.68	462.46	2,235.22
2045	2046		404.65	3,596.91	90%	3,237.22	2,832.57	485.58	2,346.98
2046	2047		424.89	3,776.76	90%	3,399.08	2,974.20	509.86	2,464.33
2047	2048		446.13	3,965.59	90%	3,569.03	3,122.91	535.36	2,587.55
2048	2049		468.44	4,163.87	90%	3,747.49	3,279.05	562.12	2,716.93
2049	2050		491.86	4,372.07	90%	3,934.86	3,443.00	590.23	2,852.77
2050	2051		516.45	4,590.67	90%	4,131.60	3,615.15	619.74	2,995.41
2051	2052		542.27	4,820.20	90%	4,338.18	3,795.91	650.73	3,145.18
2052	2053		569.39	5,061.21	90%	4,555.09	3,985.71	683.26	3,302.44
2053	2054		597.86	5,314.28	90%	4,782.85	4,184.99	717.43	3,467.56
2054	2055		627.75	5,579.99	90%	5,021.99	4,394.24	753.30	3,640.94
2055	2056		659.14	5,858.99	90%	5,273.09	4,613.95	790.96	3,822.99
2056	2057		692.09	6,151.94	90%	5,536.74	4,844.65	830.51	4,014.14
2057	2058		726.70	6,459.53	90%	5,813.58	5,086.88	872.04	4,214.85
2058	2059		763.03	6,782.51	90%	6,104.26	5,341.23	915.64	4,425.59

Period		Capital Outlay	Maintenance Expenditure & Fees	Annual Revenue with 100% occupancy	Occupancy	Net Annual Revenue	Cash Flow from Development	Leasing Revenues to SilverLine	Net Cash Flow to Developer
									(INR in Crores)
2059	2060		801.18	7,121.64	90%	6,409.47	5,608.29	961.42	4,646.87
2060	2061		841.24	7,477.72	90%	6,729.95	5,888.70	1,009.49	4,879.21
2061	2062		883.31	7,851.61	90%	7,066.44	6,183.14	1,059.97	5,123.17
2062	2063		927.47	8,244.19	90%	7,419.77	6,492.30	1,112.97	5,379.33
2063	2064		973.84	8,656.39	90%	7,790.76	6,816.91	1,168.61	5,648.30
2064	2065		1,022.54	9,089.21	90%	8,180.29	7,157.76	1,227.04	5,930.71
2065	2066		1,073.66	9,543.68	90%	8,589.31	7,515.64	1,288.40	6,227.25
2066	2067		1,127.35	10,020.86	90%	9,018.77	7,891.43	1,352.82	6,538.61
2067	2068		1,183.71	10,521.90	90%	9,469.71	8,286.00	1,420.46	6,865.54
2068	2069		1,242.90	11,048.00	90%	9,943.20	8,700.30	1,491.48	7,208.82
2069	2070		1,305.04	11,600.40	90%	10,440.36	9,135.31	1,566.05	7,569.26
2070	2071		1,370.30	12,180.42	90%	10,962.37	9,592.08	1,644.36	7,947.72
2071	2072		1,438.81	12,789.44	90%	11,510.49	10,071.68	1,726.57	8,345.11
2072	2073		1,510.75	13,428.91	90%	12,086.02	10,575.27	1,812.90	8,762.36
2073	2074		1,586.29	14,100.35	90%	12,690.32	11,104.03	1,903.55	9,200.48
2074	2075		1,665.60	14,805.37	90%	13,324.84	11,659.23	1,998.73	9,660.51
						IRR 30 Years	18.30%		16.16%

19.9.5.3 VCF application for the SilverLine Project

The Government of India has proposed the use of Value capture framework (VCF) as a means of innovative financing. Due to the transit oriented development along the SilverLine corridor, value capture opportunities shall arise and shall be utilized to generate revenues for the project.

Some of the options considered for generating VCF revenue for the SilverLine Project are covered extensively in Chapter 16.

Based on the same, the expected VCF revenues are summarised in Table 19-38.

Table 19-38: VCF Revenues of SilverLine Project

Year	VCF Revenue (INR in Crores)
2025-2026	269.18
2026-2027	275.91
2027-2028	282.81
2028-2029	289.88
2029-2030	297.13
2030-2031	304.55
2031-2032	312.17
2032-2033	319.97
2033-2034	327.97
2034-2035	336.17
2035-2036	344.57
2036-2037	353.19
2037-2038	362.02
2038-2039	371.07
2039-2040	380.35
2040-2041	389.85
2041-2042	399.60
2042-2043	409.59
2043-2044	419.83
2044-2045	430.33
2045-2046	441.08
2046-2047	452.11
2047-2048	463.41

Year	VCF Revenue (INR in Crores)
2048-2049	475.00
2049-2050	486.87
2050-2051	499.05
2051-2052	511.52
2052-2053	524.31
2053-2054	537.42
2054-2055	550.85
2055-2056	564.62
2056-2057	578.74
2057-2058	593.21
2058-2059	608.04
2059-2060	623.24
2060-2061	638.82
2061-2062	654.79
2062-2063	671.16
2063-2064	687.94
2064-2065	705.14
2065-2066	722.77
2066-2067	740.84
2067-2068	759.36
2068-2069	778.34
2069-2070	797.80
2070-2071	817.74
2071-2072	838.19
2072-2073	859.14
2073-2074	880.62
2074-2075	902.64

19.9.6 Minimization of Cash Outflow for Land

Total cost of private land is INR 6100.30 Crores. In order to minimize the cash outflow of Government of Kerala, while ensuring stable returns and monetization of ill-liquid asset for the landowner, the land owner may be paid 75% of the cost upfront and balance 25%

may be paid on an annuity basis such that 8.4% annualized returns can be ensured to the land owners.

Accordingly, from FY 25- 26 onwards, an annual annuity of INR 201 crores would be paid to the land owners as tax exempt payment over a period of 25 years.

19.9.7 Financial Internal Rate of Return

Considering the execution of the project under the Equity sharing Model (SPV model) and based on the annual cash flow streams arising from revenues of farebox, non-fare box and the Value Capture financing sources, the FIRR of the SilverLine Project has been calculated and are summarised in Table 19-39.

Table 19-39: FIRR of SilverLine Project

FIRR (50 Year)	**8.49%**
FIRR (30 Year)	**5.84%**
Equity FIRR (50 Year)	**13.55%**
Equity FIRR (30 Year)	**11.49%**

The detailed FIRR calculations are provided in Exhibit - III and Exhibit IV and the Equity FIRR calculations are provided in Exhibit -V & Exhibit VI.

19.9.7.1 Sensitivity Analysis

The sensitivity analysis has been carried out to see the impact of change in critical parameters in the range of 5% to 10% on FIRR.

The results of the sensitivity analysis for the SilverLine Project over 50 year period are summarized in Table 19-40.

Table 19-40: Sensitivity Analysis for 50 year period

Sensitivity Analysis	Range			
Parameter	**+5%**	**+10%**	**-5%**	**-10%**
Capital Cost	8.28%	8.09%	8.71%	8.95%
Operations & Maintenance Cost	8.37%	8.25%	8.60%	8.72%
Passenger Ridership	8.80%	9.10%	8.16%	7.82%

Further, the results of the sensitivity analysis for the SilverLine Project over 30 year period are summarized in Table 19-41

Table 19-41: Sensitivity Analysis for 30 year period

Sensitivity Analysis	Range			
Parameter	**+5%**	**+10%**	**-5%**	**-10%**
Capital Cost	5.56%	5.31%	6.14%	6.45%
Operations & Maintenance Cost	5.67%	5.50%	6.01%	6.17%
Passenger Ridership	6.26%	6.66%	5.40%	4.92%

The sensitivity analysis confirms that even in adverse conditions the project has a positive FIRR and is self-sufficient and viable.

19.9.8 Funding Options

Various funding options are available for the SilverLine Project.

Funding Options could be a through one or a combination of the following Options based on the Project implementation Structure:

Government Equity, Government Subordinate debt, Government grants, Private Equity with Viability Gap funding, Public Private Partnership, Equity from public participation, Loan from bilateral / multilateral agencies, Loan from Domestic institutions.

19.9.9 Financing Options

The financing option depends upon the selection of the dedicated agency created to implement the project. The following financing models have been considered for the implementation of the project.

- Equity Sharing Model (Special Purpose Vehicle fully under Government Control)
- Built, Operate & Transfer (BOT) by private sector or Public Private Partnership (PPP)

The SilverLIne Project is viable under the Equity sharing SPV model by Government of India -Ministry of Railways and Government of Kerala.

The SilverLIne Project is not viable under the Built, Operate & Transfer model even after providing viability gap funding to the private sector.

If desired, during the project execution, offers on private pubic partnership for specific components of the SilverLine Project may be solicited and based on any favourable response the same can be considered at that point of time.

19.9.9.1 Equity Sharing Model (SPV Model)

Under this model, a Special Purpose Vehicle (SPV) is set up as a joint venture between Central Government and State Government for the implementation of the project and for its subsequent Operation & Maintenance. Under this arrangement, Government of India and State Government shall provide equal equity contribution and run SPV as a commercial enterprise.

As per the prevalent practice, Central Government contributes 20% of the project cost excluding land as their equity and subordinate debt contribution. An equal amount shall be contributed by State Government. The subordinate debt is provided for funding the taxes and the subordinate debt will be repayable after servicing the principal debt provided by the bilateral/ multilateral funding agency. Further, no interest is payable on the subordinate debt. Land shall be provided by the State Government.

The remaining 60% financing is arranged as soft loan from funding agencies. Delhi Metro Rail Corporation, Bangalore Metro Rail Corporation, Chennai Metro Rail Corporation, Lucknow Metro Rail Corporation & Kolkata Metro Rail Corporation are some of the examples of success of such a SPV. Various combinations of funding using this model have been discussed in detail subsequently in this Chapter.

19.9.9.2 Built, Operate & Transfer (BOT) or Public Private Partnership (PPP)

The possibility of a public private partnership on a design, build, operate, finance and transfer (DBFOT) on a wholesome basis to a private concessionaire has been evaluated.

Usually for the weaker projects which have a good social rate of return but low financial return, the Central Government and the State Government can each contribute viability gap funding upto 20% of the project cost

Under this scheme, the private concessionaire shall construct and operate the project for 30 years, being the usual concession period, following which the project shall be handed over to the project authority. The developer shall construct the project following which he shall be responsible for maintenance of the project. During the operation period, the entire revenue from the operations shall be collected by the concessionaire.

To make the project attractive to the private concessionaire, a viability gap funding from Central and State Government to the private concessionaire has been considered. Accordingly, out of the total project completion cost of INR 63,907.55 crores to the private concessionaire, a Viability gap funding of 20% shall be provided by the Government of India amounting to INR 12,781.51 crores and an equivalent Viability gap funding of 20% shall be provided by the Government of Kerala amounting to INR 12,781.51 crores.

The balance project cost of 38,344.53 crores shall be funded through a combination of 20% equity contributed by the private concessionaire amounting to INR 7,668.91 crores and a domestic loan for 80% amounting to INR 30,675.83 crores assumed at 10% annual interest, repayable over 24 years including a 5 year moratorium period.

Accordingly, the funding structure is summarized in Table 19-42.

Table 19-42: Funding Pattern for the Private Concessionaire

Source	Amount (INR in Crores)	% Contribution
Private Concessionaire Capital Contribution	7668.91	20.00%
Loan from Domestic Funding Agency	30675.63	80.00%
Total Cost Excluding VGF	**38344.53**	**100%**
VGF by GOI / Indian Railways (20%)	12781.51	
VGF by GOK (20%)	12781.51	
Total Completion Cost	**63907.55**	

Upon the evaluation of the financial viability of the project for the private concessionaire, it is seen that over the 30 year period the Internal rate of return for the private developer is only 6.77% even after considering the viability gap funding. The detailed calculations are provided in Exhibit -VII.

The private concessionaire will expect a rate of return of at least 16% to assume the risk of execution, which is only about 4 to 6% above the bank lending rate.

Therefore, the return from the SilverLine Project on DBFOT basis is not viable and will not be acceptable to any private concessionaire.

19.9.10 DMRC/BMRC/CMRL pattern of Financing for SilverLine

DMRC, BMRC, CMRL and many other metro rail companies follow the financing model described in Para 19.9.1.1.wherein, a Special Purpose Vehicle (SPV) is set up as a joint venture between Central Government and State Government for the implementation of the project and for its subsequent Operation & Maintenance. Under this arrangement Government of India and State Government make equal equity contribution and run the SPV as a commercial enterprise. As per the prevalent practice, Central Government contributes 20% of the project cost excluding land as their equity and subordinate debt share of the project cost. An equal amount is contributed by State Government aggregating to 40% of the project cost. Remaining 60% is arranged as soft loan from funding agencies.

A similar funding structure with alternative combinations can be considered for the SPV model of funding for the SilverLine Project.

Under this funding pattern, a Special Purpose Vehicle (SPV) is to be setup under K-Rail (a joint venture between Ministry of Railways-Government of India and Government of Kerala) for the implementation of the project and for its subsequent Operation and

Maintenance and the equity contribution between Ministry of Railways-GOI and Government of Kerala shall be in the ratio of 49: 51 respectively.

Accordingly, the possible financing combinations under the SPV structure have been detailed below:

19.9.10.1 Financing Pattern on SPV model

Under this financing pattern, a Special Purpose Vehicle (SPV) under K-Rail will be created as a joint venture between Ministry of Railways -GOI and Government of Kerala for the implementation of the project and for its subsequent Operation & Maintenance.

Under this arrangement, Ministry of Railways- GOI (MOR) and The Government of Kerala shall contribute equity in the ratio of 49:51 and run the SPV as a commercial enterprise. The railway land provided by the Ministry of Railways - GOI shall be considered as Equity contribution of MOR. Together, the equity contribution shall be 40% of the total project cost excluding central taxes, State taxes, IDC and Private/State Government land.

A soft loan from bilateral/ multilateral funding institutions shall be arranged equivalent to 60% of the total project cost excluding central taxes, State taxes, IDC and Private/State Government land.

In addition to equity, Govt of India will also fund by means of subordinate debt, the amount of Central taxes.

Similarly, GOK will fund by means of subordinate debt or government grant, the amount of state taxes and the Interest during construction.

The cost of railway land shall be adjusted against the equity contribution by Ministry of Railways - GOI. The cost of private land, State government land and R & R shall be funded through a subordinate debt by the Government of Kerala. The Government of Kerala shall also provide a subordinate debt for the land on Joint development for which annuity payments shall be made to private land holders on a deferred payment basis by the Government of Kerala.

Accordingly, the funding structure is detailed in Table 19-43.

Table 19-43: Equity Funding Pattern with limited loan

Source	Amount (INR in Crores)	% Contribution	% Share of total Project Cost
Ministry Of Railways (GOI) - Equity Cash	7,713.50	17.40%	13.46%
Ministry Of Railways (GOI) - Equity Land	975.00	2.20%	
GoK Equity	9,043.13	20.40%	14.01%

Source	Amount (INR in Crores)	% Contribution	% Share of total Project Cost
Loan from bilateral/multilateral agencies	26,597.44	60.00%	41.20%
Total Cost Excluding Land, R&R & Taxes	**44,329.07**	**100%**	
Ministry Of Railways (GOI) SD for Central taxes (100%)	3,188.73		4.94%
GoK SD for Land and R&R (100%)	11,837.25		18.34%
GOK SD for Land on JDA (Deferred Payment Scheme)	1,525.08		2.36%
GOK SD for State Taxes (100%)	2,896.46		4.49%
Total Completion Cost before IDC	**63,776.59**		
IDC to be borne by GOK	**780.50**		1.21%
Total Completion Cost including IDC	**64,557.09**		100.00%

19.9.10.2 Financing Pattern on SPV model with equity dilution

Under this financing pattern, a Special Purpose Vehicle (SPV) under K-Rail will be created as a joint venture between Ministry of Railways - GOI and Government of Kerala for the implementation of the project and for its subsequent Operation & Maintenance..

Under this arrangement, the total equity contribution shall be 40% of the total project cost excluding central taxes, State taxes, IDC and Private /State Government land.

The FIRR of the project to equity shareholders is 13.55% over an operation period of 50 years which should attract equity capital through public participation. To take advantage of the expertise of private sector through their participation, 40% of the total required equity capital shall be contributed by public participation.

Kerala has been successful in raising equity funds from HNI/PSU/NRI in the past for projects like Kochi International Airport Ltd (CIAL) and recently Kannur International Airport Ltd through such route. CIAL has turned into one of the most efficiently run institutions in the state with nearly 19,000 investors.

Following the footsteps of CIAL, Kannur Airport was also modelled as Public Private Partnership and the Government of Kerala, owns around 33% of the company's shares

Ministry of Railways - GOI and Government of Kerala shall contribute the remaining 60% equity capital in the ratio of 49:51 and run the SPV as a commercial enterprise. The railway land provided by the Ministry of Railways - GOI shall be considered as Equity contribution of MOR.

A soft loan from bilateral/ multilateral funding institutions shall be arranged equivalent to 60% of the total project cost excluding central taxes, State taxes, IDC and Private/State Government land.

In addition to equity, Govt of India will also fund by means of subordinate debt, the amount of Central taxes.

Similarly, GOK will fund by means of subordinate debt or government grant, the amount of State taxes and the Interest during construction.

The cost of railway land shall be adjusted against the equity contribution by Ministry of Railways -GOI. The cost of private land, State government land and R & R shall be funded through a subordinate debt from the Government of Kerala. The Government of Kerala shall also provide a subordinate debt for the land on Joint development for which annuity payments shall be made to private land holders on a deferred payment basis by the Government of Kerala.

Accordingly, the funding structure is detailed in Table 19-44

Table 19-44: Equity Funding Pattern with equity dilution and limited loan

Source	Amount (INR in Crores)	% Contribution	% Share of Total Project Cost
Ministry Of Railways (GOI) - Equity Cash	4,238.10	9.56%	8.08%
Ministry Of Railways (GOI) - Equity Land	975.00	2.20%	
GoK Equity	5,425.88	12.24%	8.40%
Public Equity Participation	7,092.65	16.00%	10.99%
Loan from bilateral/multilateral agencies	26,597.44	60.00%	41.20%
Total Cost Excluding Land, R&R & Taxes	**44,329.07**	**100%**	
Ministry Of Railways (GOI) SD for Central taxes (100%)	3,188.73		4.94%
GoK SD for Land and R&R (100%)	11,837.25		18.34%
GOK SD for Land on JDA (Deferred Payment Scheme)	1,525.08		2.36%
GOK SD for State Taxes (100%)	2,896.46		4.49%
Total Completion Cost before IDC	**63,776.59**		
IDC to be borne by GOK	**780.50**		1.21%
Total Completion Cost including IDC	**64,557.09**		100.00%

19.9.10.3 Financing Pattern on SPV model with higher loan component

Under this financing pattern, a Special Purpose Vehicle (SPV) under K-Rail will be created as a joint venture between Ministry of Railways - GOI and Government of Kerala for the implementation of the project and for its subsequent Operation & Maintenance..

Under this arrangement, the total equity contribution shall be about 24% of the total project cost excluding central taxes, State Taxes, IDC and Private and State Government Land.

The equity contribution is determined as the residual project Cost to be financed by the shareholders by excluding from the project cost, the soft loan taken from the multilateral/ bilateral agency.

Ministry of Railways -GOI and Government of Kerala shall contribute the equity in the ratio of 49:51 and run the SPV as a commercial enterprise. The railway land provided by the Ministry of Railways - GOI shall be considered as Equity contribution of MOR.

A soft loan shall be arranged from bilateral/ multilateral funding institutions equivalent to 60% of the value of total project assets including Private/ State Government land but excluding the central taxes, State taxes, IDC. This arrangement may be possible for loans obtained from certain bilateral/ multilateral institutions where there is no restriction on the amount of the loan but the loan may be subject to other restrictions on sourcing of materials. The percentage of loan available from the funding agencies would be finalised after discussions/ negotiations with the bilateral / multilateral funding institutions.

Accordingly, the Soft loan from bilateral/ multilateral funding institutions is equivalent to about 74% of the total project cost excluding central taxes, State Taxes, IDC and Private and State Government Land.

In addition to equity, Government of India will also fund by means of subordinate debt, the amount of Central taxes. Similarly, GOK will fund by means of subordinate debt or government grant, the amount of state taxes and the Interest during construction.

The cost of railway land shall be adjusted against the equity contribution by Ministry of Railways -GOI. The cost of private land, State government land and R & R shall be funded through a subordinate debt from the Government of Kerala. The Government of Kerala shall also provide a subordinate debt for the land on Joint development for which annuity payments shall be made to private land holders on a deferred payment basis by the Government of Kerala

Accordingly, the funding structure is detailed in Table 19-45

Table 19-45: Equity Funding Pattern with higher loan component

Source	Amount (INR in Crores)	% Contribution	% Share of total Project Cost
Ministry Of Railways (GOI) - Equity Cash	4,233.34	9.55%	8.15%
Ministry Of Railways (GOI) - Equity Land	975.00	2.20%	
GoK Equity	5,420.93	12.23%	8.48%
Loan from bilateral/multilateral agencies	33,699.80	76.02%	52.70%
Total Cost Excluding Land, R&R & Taxes	**44,329.07**	**100%**	
Ministry Of Railways (GOI) SD for Central taxes (100%)	3,188.73		4.99%
GoK SD for Land and R&R (100%)	11,837.25		18.51%
GOK SD for Land on JDA (Deferred Payment Scheme)	1,525.08		2.38%
GOK SD for State Taxes (100%)	2,896.46		4.53%
Total Completion Cost before IDC	**63,776.59**		
IDC to be borne by GOK	**164.08**		0.26%
Total Completion Cost including IDC	**63,940.67**		100.00%

19.9.10.4 Financing Pattern on SPV model with equity dilution and higher loan component

Under this financing pattern, a Special Purpose Vehicle (SPV) under K-Rail will be created as a joint venture between Ministry of Railways -GOI and Government of Kerala for the implementation of the project and for its subsequent Operation & Maintenance.

Under this arrangement, the total equity contribution shall be about 24% of the total project cost excluding central taxes, State Taxes, IDC and Private and State Government Land.
The equity contribution is determined as the residual project Cost to be financed by the shareholders by excluding from the project cost, the loan taken from the multilateral/ bilateral funding institutions.

The FIRR of the project to equity shareholders is 13.55% over an operation period of 50 years which should attract public equity participation. To take advantage of the expertise of private sector through their participation, 40% of the above 24% equity capital is proposed to be raised from public participation.

Kerala has been successful in raising equity funds from HNI/PSU/NRI in the past for projects like Kochi International Airport Ltd (CIAL) and recently Kannur International

Airport Ltd through such route. CIAL has turned into one of the most efficiently run institutions in the state with nearly 19,000 investors.

Following the footsteps of CIAL, Kannur Airport was also modelled as Public Private Partnership and the Government of Kerala, owns around 33% of the company's shares.

Ministry of Railways -GOI and Government of Kerala shall contribute the remaining 60% equity in the ratio of 49:51 and run the SPV as a commercial enterprise. The railway land provided by the Ministry of Railways -GOI shall be considered as Equity contribution of MOR.

A soft loan shall be arranged from bilateral/ multilateral funding institutions equivalent to 60% of the value of total project assets including Private/ State Government land but excluding the central taxes, State taxes, IDC. This arrangement may be possible for loans obtained from certain bilateral/ multilateral institutions where there is no restriction on the amount of the loan but the loan may be subject to other restrictions on sourcing of materials. The percentage of loan available from the funding agencies would be finalised after discussions/ negotiations with the bilateral / multilateral funding institutions.

Accordingly, the Soft loan from bilateral/ multilateral funding institutions is equivalent to about 74% of the total project cost excluding central taxes, State Taxes, IDC and Private and State Government Land.

In addition to equity, Government of India will also fund by means of subordinate debt, the amount of Central taxes. Similarly, GOK will fund by means of subordinate debt or government grant, the amount of State taxes and the Interest during construction

The cost of railway land shall be adjusted against the equity contribution by Ministry of Railways -GOI. The cost of private land, State government land and R & R shall be funded through a subordinate debt from the Government of Kerala. The Government of Kerala shall also provide a subordinate debt for the land on Joint development for which annuity payments shall be made to private land holders on a deferred payment basis by the Government of Kerala

Accordingly, the financing structure is detailed in Table 19-46.

Table 19-46: SPV model with equity dilution and higher loan component

<table>
<tr><th>Source</th><th>Amount (INR in Crores)</th><th>% Contribution</th><th>% Share of total Project Cost</th></tr>
<tr><td>Ministry Of Railways (GOI) - Equity Cash</td><td>2,150.00</td><td>4.85%</td><td rowspan="2">4.89%</td></tr>
<tr><td>Ministry Of Railways (GOI) - Equity Land</td><td>975.00</td><td>2.20%</td></tr>
<tr><td>GoK Equity</td><td>3,252.56</td><td>7.34%</td><td>5.09%</td></tr>
<tr><td>Public Equity Participation</td><td>4,251.71</td><td>9.59%</td><td>6.65%</td></tr>
</table>

Source	Amount (INR in Crores)	% Contribution	% Share of total Project Cost
Loan from bilateral/multilateral agencies	33,699.80	76.02%	52.70%
Total Cost Excluding Land, R&R & Taxes	**44,329.07**	**100%**	
Ministry Of Railways (GOI) SD for Central taxes (100%)	3,188.73		4.99%
GoK SD for Land and R&R (100%)	11,837.25		18.51%
GOK SD for Land on JDA (Deferred Payment Scheme)	1,525.08		2.38%
GOK SD for State Taxes (100%)	2,896.46		4.53%
Total Completion Cost before IDC	**63,776.59**		
IDC to be borne by GOK	**164.08**		0.26%
Total Completion Cost including IDC	**63,940.67**		100.00%

19.9.11 Conclusion and Recommendation

Based on the above discussions, the following are the conclusions and recommendations:

- The SilverLIne Project is not viable under the Built, Operate & Transfer model even after providing viability gap funding to the private sector .

- The SilverLIne Project is viable under the Equity sharing SPV model wherein a Special Purpose Vehicle (SPV) under K-Rail will be created as a joint venture between Ministry of Railways -GOI and Government of Kerala for the implementation of the project and for its subsequent Operation & Maintenance.

- The outcomes of EIRR and FIRR for the SilverLine Project are indicated in Table 19-47.

Table 19-47: Project EIRR & FIRR

EIRR (50 Year)	**24.04%**
EIRR (30 Year)	**23.99%**
FIRR (50 Year)	**8.49%**
FIRR (30 Year)	**5.84%**
Equity FIRR (50 Year)	**13.55%**
Equity FIRR (30 Year)	**11.49%**

- As the project is self-sustainable as seen from the FIRR and also has an EIRR above the mandated levels, the project is financially & economically viable and hence is recommended to be implemented.

- If desired, during the project execution, offers on private pubic partnership for specific components of the SilverLine Project may be solicited and based on any favourable response the same can be considered at that point of time.

- The Government of Kerala has been successful in raising equity funds from HNI/PSU/NRI in financing the Kannur International Airport and Cochin International Airport. Considering the same, the preferred financing structure detailed in Table 19-48 on SPV basis as elaborately discussed in 19.9.10.4 is recommended for the implementation of the project, if so desired and acceptable to all the stakeholders.

Table 19-48: SPV model with equity dilution and higher loan component

Source	Amount (INR in Crores)	% Contribution	% Share of total Project Cost
Ministry Of Railways (GOI) - Equity Cash	2,150.00	4.85%	4.89%
Ministry Of Railways (GOI) - Equity Land	975.00	2.20%	
GoK Equity	3,252.56	7.34%	5.09%
Public Equity Participation	4,251.71	9.59%	6.65%
Loan from bilateral/multilateral agencies	33,699.80	76.02%	52.70%
Total Cost Excluding Land, R&R & Taxes	**44,329.07**	**100%**	
Ministry Of Railways (GOI) SD for Central taxes (100%)	3,188.73		4.99%
GoK SD for Land and R&R (100%)	11,837.25		18.51%
GOK SD for Land on JDA (Deferred Payment Scheme)	1,525.08		2.38%
GOK SD for State Taxes (100%)	2,896.46		4.53%
Total Completion Cost before IDC	**63,776.59**		
IDC to be borne by GOK	**164.08**		0.26%
Total Completion Cost including IDC	**63,940.67**		100.00%

Based on the above funding structure, the annual project cash flow requirement based on the project phasing has been estimated and is provided in Table 19-49

Table 19-49: Phasing of Project Funds (INR in Crores)

Particulars	FY 2020-21	FY 2021-22	FY 2022-23	FY 2023-24	FY 2024-25	FY 2025-26	Total
Government of Kerala							
Subordinate Debt / Grant - State Taxes	6.20	297.88	627.34	879.76	766.82	318.45	2,896.46
Subordinate Debt - Land	1,526.63	5,706.44	4,528.06	76.12	-	-	11,837.25
Equity Contribution - Construction Cost	41.50	773.88	1,326.08	1,111.10			3,252.56
Subordinate Debt / Grant - IDC	-	3.22	13.89	31.82	51.30	63.85	164.08
Total Government of Kerala Contribution	**1,574.34**	**6,781.42**	**6,495.37**	**2,098.81**	**818.12**	**382.31**	**18,150.36**
Government Of India							
Subordinate Debt / Grant - Central Taxes	6.20	310.89	664.75	977.85	867.11	361.92	3,188.73
Equity Contribution - Land Cost	12.44	231.98	397.51	333.07			975.00
Equity Contribution - Construction Cost	27.43	511.55	876.56	734.46			2,150.01
Total Central Government Contribution	**46.08**	**1,054.43**	**1,938.83**	**2,045.38**	**867.11**	**361.92**	**6,313.74**
Public Participation - Equity Construction Cost				**928.19**	**2,383.99**	**939.52**	**4,251.70**
Debt from Multilateral Funding Institutions	**-**	**3,216.05**	**7,458.73**	**10,474.46**	**9,002.62**	**3,547.93**	**33,699.80**
Total Fund Requirement - FY 2020-21 to FY 2025-26	**1,620.42**	**11,051.89**	**15,892.93**	**15,546.84**	**13,071.84**	**5,231.67**	**62,415.60**
GOK SD for Land on JDA (Deferred Payment Scheme)							1,525.08
Total Project Cost - Funding Requirement							**63,940.67**

EXHIBIT I – Project EIRR over 50-year Stream (INR in Crores)

Project Cash Flows & EIRR

Year		Capital Outlay	Repalcement Cost	Additional CAPEX	O & M Expenditure	Total Social Cost	Travel Time Saving	VOC Savings	Pollution Cost Savings	Accident Cost Saving	Infra Cost Savings	Total Social Benefits	Net Cash Inflow/ (Outflow)
2020	2021	1,492				1,492	-	-	-	-	-	-	(1,492)
2021	2022	8,693				8,693	-	-	-	-	3,654	3,654	(5,039)
2022	2023	11,181				11,181	-	-	-	-	3,654	3,654	(7,527)
2023	2024	9,585				9,585	-	-	-	-	3,654	3,654	(5,931)
2024	2025	7,619				7,619	-	-	-	-	3,698	3,698	(3,921)
2025	2026	2,862	-		849	3,711	6,471	1,455	67	1	3,719	11,714	8,002
2026	2027		49		849	898	6,746	1,518	70	1	65	8,401	7,503
2027	2028		49		849	898	7,034	1,585	72	2	65	8,758	7,859
2028	2029		49		849	898	7,332	1,654	74	2	65	9,127	8,229
2029	2030		49	478	872	1,399	7,644	1,727	76	2	65	9,514	8,115
2030	2031		52	-	872	925	7,970	1,803	78	2	65	9,918	8,993
2031	2032		52	-	869	922	8,217	1,848	80	2	87	10,234	9,312
2032	2033		52	-	869	922	8,472	1,910	81	2	87	10,552	9,630
2033	2034		52	-	869	922	8,736	1,973	83	2	87	10,881	9,959
2034	2035		67	-	869	936	9,008	2,039	85	2	87	11,221	10,285
2035	2036		505	-	1,001	1,507	9,289	2,107	87	2	87	11,572	10,065
2036	2037		116	-	1,001	1,118	9,516	2,161	88	2	87	11,854	10,737
2037	2038		116	-	1,001	1,118	9,749	2,216	89	2	87	12,144	11,026
2038	2039		120	-	1,001	1,121	9,987	2,273	91	2	87	12,440	11,319
2039	2040		120	-	1,001	1,121	10,231	2,331	92	2	87	12,744	11,623
2040	2041		953	-	1,001	1,954	10,482	2,356	94	2	87	13,021	11,067
2041	2042		269	1,594	1,061	2,924	10,647	2,397	95	2	109	13,250	10,326
2042	2043		71	-	1,061	1,132	10,814	2,439	96	2	109	13,460	12,329
2043	2044		71	-	1,061	1,132	10,985	2,482	97	2	109	13,675	12,543
2044	2045		71	-	1,061	1,132	11,158	2,525	98	2	109	13,893	12,761
2045	2046		1,432	-	1,061	2,493	11,334	2,570	100	2	109	14,114	11,622
2046	2047		269	-	1,061	1,330	11,513	2,615	101	3	109	14,339	13,009
2047	2048		77	-	1,061	1,139	11,694	2,660	102	3	109	14,568	13,429
2048	2049		77	-	1,061	1,139	11,879	2,706	103	3	109	14,800	13,662
2049	2050		77	-	1,061	1,139	12,067	2,753	104	3	109	15,036	13,898
2050	2051		1,192	-	1,061	2,253	12,258	2,801	106	3	109	15,276	13,023
2051	2052		259	-	1,061	1,320	12,452	2,828	107	3	109	15,499	14,179
2052	2053		338	996	1,101	2,435	12,650	2,882	108	3	109	15,752	13,316
2053	2054		259	-	1,101	1,360	12,851	2,928	109	3	120	16,011	14,651
2054	2055		259	-	1,101	1,360	13,055	2,975	111	3	120	16,263	14,903
2055	2056		2,395	-	1,101	3,495	13,267	3,024	112	3	120	16,525	13,030
2056	2057		63	-	1,101	1,163	13,482	3,074	114	3	120	16,792	15,629
2057	2058		302	-	1,101	1,402	13,701	3,126	115	3	120	17,064	15,662
2058	2059		63	-	1,101	1,163	13,923	3,178	117	3	120	17,341	16,177
2059	2060		63	-	1,101	1,163	14,150	3,231	118	3	120	17,622	16,459
2060	2061		1,004	-	1,101	2,104	14,380	3,286	120	3	120	17,908	15,804
2061	2062		319	-	1,101	1,420	14,615	3,341	121	3	120	18,200	16,780
2062	2063		558	-	1,143	1,701	14,853	3,397	123	3	120	18,496	16,795
2063	2064		379	-	1,143	1,522	15,096	3,455	125	3	120	18,798	17,276
2064	2065		319	-	1,143	1,462	15,342	3,513	126	3	120	19,105	17,643
2065	2066		783	-	1,143	1,926	15,593	3,573	128	3	120	19,417	17,491
2066	2067		262	-	1,143	1,405	15,848	3,634	130	3	131	19,746	18,341
2067	2068		272	-	1,143	1,415	16,108	3,696	131	3	131	20,069	18,654
2068	2069		292	-	1,143	1,435	16,372	3,759	133	4	131	20,398	18,962
2069	2070		113	-	1,143	1,256	16,640	3,823	135	4	131	20,732	19,476
2070	2071		629	-	1,143	1,772	16,913	3,888	137	4	131	21,073	19,301
2071	2072		116	-	1,143	1,259	17,191	3,955	139	4	131	21,419	20,160
2072	2073		306	-	1,193	1,499	17,474	4,023	141	4	131	21,772	20,273
2073	2074		246	-	1,193	1,439	17,761	4,092	143	4	131	22,130	20,691
2074	2075	(7,075)	18	-	1,193	(5,865)	18,053	4,163	145	4	131	22,495	28,360
		34,357	15,622	3,068	52,317	105,363			5,297	134	23,610	781,793	676,430
												EIRR	24.04%
												ENPV 14%	19,019.57

EXHIBIT II – Project EIRR over 30-year Stream (INR in Crores)

Year		Capital Outlay	Repalcement Cost	Additional CAPEX	O & M Expenditure	Total Social Cost	Travel Time Saving	VOC Savings	Pollution Cost Savings	Accident Cost Saving	Infra Cost Savings	Total Social Benefits	Net Cash Inflow/ (Outflow)
2020	2021	1,492				1,492	-	-	-	-	-	-	(1,492)
2021	2022	8,693				8,693	-	-	-	-	3,654	3,654	(5,039)
2022	2023	11,181				11,181	-	-	-	-	3,654	3,654	(7,527)
2023	2024	9,585				9,585	-	-	-	-	3,654	3,654	(5,931)
2024	2025	7,619				7,619	-	-	-	-	3,698	3,698	(3,921)
2025	2026	2,862	-		849	3,711	6,471	1,455	67	1	3,719	11,714	8,002
2026	2027		49		849	898	6,746	1,518	70	1	65	8,401	7,503
2027	2028		49		849	898	7,034	1,585	72	2	65	8,758	7,859
2028	2029		49		849	898	7,332	1,654	74	2	65	9,127	8,229
2029	2030		49	478	872	1,399	7,644	1,727	76	2	65	9,514	8,115
2030	2031		52	-	872	925	7,970	1,803	78	2	65	9,918	8,993
2031	2032		52	-	869	922	8,217	1,848	80	2	87	10,234	9,312
2032	2033		52	-	869	922	8,472	1,910	81	2	87	10,552	9,630
2033	2034		52	-	869	922	8,736	1,973	83	2	87	10,881	9,959
2034	2035		67	-	869	936	9,008	2,039	85	2	87	11,221	10,285
2035	2036		505	-	1,001	1,507	9,289	2,107	87	2	87	11,572	10,065
2036	2037		116	-	1,001	1,118	9,516	2,161	88	2	87	11,854	10,737
2037	2038		116	-	1,001	1,118	9,749	2,216	89	2	87	12,144	11,026
2038	2039		120	-	1,001	1,121	9,987	2,273	91	2	87	12,440	11,319
2039	2040		120	-	1,001	1,121	10,231	2,331	92	2	87	12,744	11,623
2040	2041		953	-	1,001	1,954	10,482	2,356	94	2	87	13,021	11,067
2041	2042		269	1,594	1,061	2,924	10,647	2,397	95	2	109	13,250	10,326
2042	2043		71	-	1,061	1,132	10,814	2,439	96	2	109	13,460	12,329
2043	2044		71	-	1,061	1,132	10,985	2,482	97	2	109	13,675	12,543
2044	2045		71	-	1,061	1,132	11,158	2,525	98	2	109	13,893	12,761
2045	2046		1,432	-	1,061	2,493	11,334	2,570	100	2	109	14,114	11,622
2046	2047		269	-	1,061	1,330	11,513	2,615	101	3	109	14,339	13,009
2047	2048		77	-	1,061	1,139	11,694	2,660	102	3	109	14,568	13,429
2048	2049		77	-	1,061	1,139	11,879	2,706	103	3	109	14,800	13,662
2049	2050		77	-	1,061	1,139	12,067	2,753	104	3	109	15,036	13,898
2050	2051		1,192	-	1,061	2,253	12,258	2,801	106	3	109	15,276	13,023
2051	2052		259	-	1,061	1,320	12,452	2,828	107	3	109	15,499	14,179
2052	2053		338	996	1,101	2,435	12,650	2,882	108	3	109	15,752	13,316
2053	2054		259	-	1,101	1,360	12,851	2,928	109	3	120	16,011	14,651
2054	2055	(5,872)	259	-	1,101	(4,513)	13,055	2,975	111	3	120	16,263	20,776
		35,560	7,122	3,068	29,604	75,353			2,745	66	21,119	394,690	319,337
												EIRR	23.99%
												ENPV 14%	17,964.65

EXHIBIT III – Project FIRR over 50-year Stream (INR in Crores)

Year		Capital Outlay	Land - JDA Outlay	Repalcement Cost	Additional CAPEX	O & M Expenditure	Total Cash Outflows	Fare Box Revenues	Non Fare Box Revenues	VCF Revenues	Total Revenues	Net Cash Inflow/ (Outflow)
2020	2021	1,620					1,620				-	(1,620)
2021	2022	11,049					11,049				-	(11,049)
2022	2023	15,879					15,879				-	(15,879)
2023	2024	15,515					15,515				-	(15,515)
2024	2025	13,021					13,021				-	(13,021)
2025	2026	5,168	201	-		1,263	6,632	2,513	149	269	2,931	(3,701)
2026	2027		201	79		1,333	1,613	2,774	167	276	3,217	1,604
2027	2028		201	83		1,407	1,691	3,062	187	283	3,531	1,840
2028	2029		201	87		1,486	1,774	3,373	208	290	3,871	2,097
2029	2030		201	92	894	1,600	2,786	3,717	230	297	4,245	1,459
2030	2031		201	103	-	1,689	1,993	4,097	255	305	4,657	2,663
2031	2032		201	108	-	1,779	2,088	4,470	281	312	5,064	2,975
2032	2033		201	113	-	1,880	2,195	4,878	295	320	5,494	3,299
2033	2034		201	119	-	1,988	2,308	5,324	310	328	5,962	3,654
2034	2035		201	160	-	2,102	2,464	5,811	326	336	6,472	4,009
2035	2036		201	1,265	-	2,556	4,022	6,343	342	345	7,029	3,007
2036	2037		201	306	-	2,702	3,208	6,879	359	353	7,591	4,383
2037	2038		201	321	-	2,857	3,379	7,461	377	362	8,200	4,821
2038	2039		201	347	-	3,022	3,569	8,093	396	371	8,860	5,290
2039	2040		201	364	-	3,197	3,762	8,779	416	380	9,575	5,813
2040	2041		201	3,045	-	3,383	6,629	9,523	437	390	10,349	3,720
2041	2042		201	903	5,349	3,692	10,144	10,249	458	400	11,107	962
2042	2043		201	249	-	3,906	4,355	11,030	481	410	11,921	7,565
2043	2044		201	261	-	4,133	4,595	11,871	505	420	12,796	8,201
2044	2045		201	274	-	4,375	4,851	12,777	531	430	13,738	8,887
2045	2046		201	5,841	-	4,633	10,675	13,752	557	441	14,750	4,075
2046	2047		201	1,152	-	4,907	6,260	14,801	585	452	15,839	9,578
2047	2048		201	348	-	5,199	5,748	15,932	614	463	17,009	11,262
2048	2049		201	365	-	5,510	6,076	17,149	645	475	18,269	12,193
2049	2050		201	383	-	5,841	6,425	18,459	677	487	19,623	13,199
2050	2051			6,207	-	6,193	12,400	19,870	711	499	21,080	8,680
2051	2052			1,415	-	6,568	7,983	21,390	747	512	22,648	14,664
2052	2053			1,943	5,718	7,069	14,730	23,026	784	524	24,334	9,604
2053	2054			1,560	-	7,499	9,059	24,787	823	537	26,148	17,089
2054	2055			1,638	-	7,956	9,595	26,685	864	551	28,100	18,505
2055	2056			15,914	-	8,445	24,359	28,454	907	565	29,927	5,568
2056	2057			437	-	8,965	9,402	30,342	953	579	31,874	22,472
2057	2058			2,210	-	9,520	11,730	32,355	1,000	593	33,949	22,219
2058	2059			481	-	10,113	10,594	34,503	1,051	608	36,161	25,568
2059	2060			505	-	10,745	11,250	36,793	1,103	623	38,519	27,269
2060	2061			8,513	-	11,419	19,932	39,236	1,158	639	41,033	21,101
2061	2062			2,840	-	12,140	14,980	41,843	1,216	655	43,714	28,734
2062	2063			5,217	-	13,054	18,271	44,622	1,277	671	46,571	28,299
2063	2064			3,718	-	13,880	17,598	47,588	1,341	688	49,617	32,019
2064	2065			3,288	-	14,761	18,049	50,751	1,408	705	52,864	34,815
2065	2066			8,472	-	15,704	24,175	54,126	1,478	723	56,327	32,151
2066	2067			2,980	-	16,710	19,690	57,726	1,552	741	60,019	40,329
2067	2068			3,249	-	17,786	21,035	61,566	1,630	759	63,955	42,920
2068	2069			3,661	-	18,937	22,597	65,663	1,711	778	68,153	45,556
2069	2070			1,485	-	20,166	21,651	70,035	1,797	798	72,630	50,978
2070	2071			8,690	-	21,482	30,171	74,699	1,887	818	77,403	47,232
2071	2072			1,686	-	22,888	24,574	79,675	1,981	838	82,494	57,919
2072	2073			4,664	-	24,623	29,287	84,983	2,080	859	87,922	58,636
2073	2074			3,941	-	26,240	30,181	90,647	2,184	881	93,712	63,531
2074	2075	(7,075)		304	-	27,971	21,199	96,690	2,293	903	99,886	78,687
		55,176	5,027	111,385	11,961	437,273	620,821	1,451,173	43,724	26,241	1,521,138	900,317
											IRR	8.49%

EXHIBIT IV – Project Equity FIRR over 50-year Stream (INR in Crores)

Year		Capital Outlay	Land - JDA Outlay	O & M Expenditure	Repalcement Cost	Additional CAPEX	Total Cash Outflows	Fare Box Revenues	Non Fare Box Revenues	VCF Revenues	Total Revenues	Loan Funds	IDC	Loan Repayment	Forex Fluctuation	Principal	Interest	Outstanding Principal	Subordinate Debt	Subordinate Debt Repayment	Net Cash Inflow/ (Outflow)
														36,238.58	3%						
2020	2021	1,620	-	-	-	-	1,620	-	-	-	-	-	-		-			-	1,368	-	(253)
2021	2022	11,049	-	-	-	-	11,049	-	-	-	-	3,216	3		48			3,264	5,645	-	(2,187)
2022	2023	15,879	-	-	-	-	15,879	-	-	-	-	7,459	14		210			10,933	5,319	-	(3,101)
2023	2024	15,515	-	-	-	-	15,515	-	-	-	-	10,474	32		485			21,892	2,204	-	(2,837)
2024	2025	13,021	-	-	-	-	13,021	-	-	-	-	9,003	51		792			31,687	1,634	-	(2,384)
2025	2026	5,168	201	1,263	-	-	6,632	2,513	149	269	2,931	3,548	64		1,004			36,239	881	-	729
2026	2027	-	201	1,333	79	-	1,613	2,774	167	276	3,217			(1,946)	(58)	1,873	72	34,365	201	-	(199)
2027	2028	-	201	1,407	83	-	1,691	3,062	187	283	3,531			(1,946)	(118)	1,877	69	32,488	201	-	(23)
2028	2029	-	201	1,486	87	-	1,774	3,373	208	290	3,871			(1,946)	(180)	1,881	65	30,608	201	-	172
2029	2030	-	201	1,600	92	894	2,786	3,717	230	297	4,245			(1,946)	(244)	1,884	61	28,723	201	-	(530)
2030	2031	-	201	1,689	103	-	1,993	4,097	255	305	4,657			(1,946)	(310)	1,888	57	26,835	201	-	609
2031	2032	-	201	1,779	108	-	2,088	4,470	281	312	5,064			(1,946)	(378)	1,892	54	24,943	201	-	853
2032	2033	-	201	1,880	113	-	2,195	4,878	295	320	5,494			(1,946)	(447)	1,896	50	23,047	201	-	1,107
2033	2034	-	201	1,988	119	-	2,308	5,324	310	328	5,962			(1,946)	(519)	1,900	46	21,148	201	-	1,390
2034	2035	-	201	2,102	160	-	2,464	5,811	326	336	6,472			(1,946)	(593)	1,903	42	19,244	201	-	1,671
2035	2036	-	201	2,556	1,265	-	4,022	6,343	342	345	7,029			(1,946)	(669)	1,907	38	17,337	201	-	594
2036	2037	-	201	2,702	306	-	3,208	6,879	359	353	7,591			(1,946)	(748)	1,911	35	15,426	201	-	1,891
2037	2038	-	201	2,857	321	-	3,379	7,461	377	362	8,200			(1,946)	(828)	1,915	31	13,511	201	-	2,248
2038	2039	-	201	3,022	347	-	3,569	8,093	396	371	8,860			(1,946)	(912)	1,919	27	11,593	201	-	2,634
2039	2040	-	201	3,197	364	-	3,762	8,779	416	380	9,575			(1,946)	(997)	1,922	23	9,670	201	-	3,071
2040	2041	-	201	3,383	3,045	-	6,629	9,523	437	390	10,349			(1,946)	(1,086)	1,926	19	7,744	201	-	890
2041	2042	-	201	3,692	903	5,349	10,144	10,249	458	400	11,107			(1,946)	(1,177)	1,930	15	5,814	201	-	(1,959)
2042	2043	-	201	3,906	249	-	4,355	11,030	481	410	11,921			(1,946)	(1,270)	1,934	12	3,880	201	-	4,551
2043	2044	-	201	4,133	261	-	4,595	11,871	505	420	12,796			(1,946)	(1,367)	1,938	8	1,942	201	-	5,090
2044	2045	-	201	4,375	274	-	4,851	12,777	531	430	13,738			(1,946)	(1,466)	1,942	4	-	201	-	5,677
2045	2046	-	201	4,633	5,841	-	10,675	13,752	557	441	14,750								201	(2,188)	2,089
2046	2047	-	201	4,907	1,152	-	6,260	14,801	585	452	15,839								201	(2,188)	7,592
2047	2048	-	201	5,199	348	-	5,748	15,932	614	463	17,009								201	(2,188)	9,275
2048	2049	-	201	5,510	365	-	6,076	17,149	645	475	18,269								201	(2,188)	10,207
2049	2050	-	201	5,841	383	-	6,425	18,459	677	487	19,623								201	(2,188)	11,212
2050	2051	-	-	6,193	6,207	-	12,400	19,870	711	499	21,080								-	(2,188)	6,492
2051	2052	-	-	6,568	1,415	-	7,983	21,390	747	512	22,648								-	(2,188)	12,476
2052	2053	-	-	7,069	1,943	5,718	14,730	23,026	784	524	24,334								-	(2,188)	7,416
2053	2054	-	-	7,499	1,560	-	9,059	24,787	823	537	26,148								-	(2,188)	14,902
2054	2055	-	-	7,956	1,638	-	9,595	26,685	864	551	28,100								-	(2,188)	16,318
2055	2056	-	-	8,445	15,914	-	24,359	28,454	907	565	29,927								-	-	5,568
2056	2057	-	-	8,965	437	-	9,402	30,342	953	579	31,874								-	-	22,472
2057	2058	-	-	9,520	2,210	-	11,730	32,355	1,000	593	33,949								-	-	22,219
2058	2059	-	-	10,113	481	-	10,594	34,503	1,051	608	36,161								-	-	25,568
2059	2060	-	-	10,745	505	-	11,250	36,793	1,103	623	38,519								-	-	27,269
2060	2061	-	-	11,419	8,513	-	19,932	39,236	1,158	639	41,033								-	-	21,101
2061	2062	-	-	12,140	2,840	-	14,980	41,843	1,216	655	43,714								-	-	28,734
2062	2063	-	-	13,054	5,217	-	18,271	44,622	1,277	671	46,571								-	-	28,299
2063	2064	-	-	13,880	3,718	-	17,598	47,588	1,341	688	49,617								-	-	32,019
2064	2065	-	-	14,761	3,288	-	18,049	50,751	1,408	705	52,864								-	-	34,815
2065	2066	-	-	15,704	8,472	-	24,175	54,126	1,478	723	56,327								-	-	32,151
2066	2067	-	-	16,710	2,980	-	19,690	57,726	1,552	741	60,019								-	-	40,329
2067	2068	-	-	17,786	3,249	-	21,035	61,566	1,630	759	63,955								-	-	42,920
2068	2069	-	-	18,937	3,661	-	22,597	65,663	1,711	778	68,153								-	-	45,556
2069	2070	-	-	20,166	1,485	-	21,651	70,035	1,797	798	72,630								-	-	50,978
2070	2071	-	-	21,482	8,690	-	30,171	74,699	1,887	818	77,403								-	-	47,232
2071	2072	-	-	22,888	1,686	-	24,574	79,675	1,981	838	82,494								-	-	57,919
2072	2073	-	-	24,623	4,664	-	29,287	84,983	2,080	859	87,922								-	-	58,636
2073	2074	-	-	26,240	3,941	-	30,181	90,647	2,184	881	93,712								-	-	63,531
2074	2075	(7,075)	-	27,971	304	-	21,199	96,690	2,293	903	99,886								-	-	78,687
		55,176	5,027	437,273	111,385	11,961	620,821	1,451,173	43,724	26,241	1,521,138	33,700	164	(36,968)		36,239	729	432,334	21,877	(21,877)	883,681
																			IRR		13.55%
																			NPV 12% (Rs Crores)		3,301.62

EXHIBIT V – Project FIRR over 30-year Stream (INR in Crores)

Year		Capital Outlay	Land - JDA Outlay	Repalcement Cost	Additional CAPEX	O & M Expenditure	Total Cash Outflows	Fare Box Revenues	Non Fare Box Revenues	VCF Revenues	Total Revenues	Net Cash Inflow/ (Outflow)
2020	2021	1,620					1,620				-	(1,620)
2021	2022	11,049					11,049				-	(11,049)
2022	2023	15,879					15,879				-	(15,879)
2023	2024	15,515					15,515				-	(15,515)
2024	2025	13,021					13,021				-	(13,021)
2025	2026	5,168	201	-		1,263	6,632	2,513	149	269	2,931	(3,701)
2026	2027		201	79		1,333	1,613	2,774	167	276	3,217	1,604
2027	2028		201	83		1,407	1,691	3,062	187	283	3,531	1,840
2028	2029		201	87		1,486	1,774	3,373	208	290	3,871	2,097
2029	2030		201	92	894	1,600	2,786	3,717	230	297	4,245	1,459
2030	2031		201	103	-	1,689	1,993	4,097	255	305	4,657	2,663
2031	2032		201	108	-	1,779	2,088	4,470	281	312	5,064	2,975
2032	2033		201	113	-	1,880	2,195	4,878	295	320	5,494	3,299
2033	2034		201	119	-	1,988	2,308	5,324	310	328	5,962	3,654
2034	2035		201	160	-	2,102	2,464	5,811	326	336	6,472	4,009
2035	2036		201	1,265	-	2,556	4,022	6,343	342	345	7,029	3,007
2036	2037		201	306	-	2,702	3,208	6,879	359	353	7,591	4,383
2037	2038		201	321	-	2,857	3,379	7,461	377	362	8,200	4,821
2038	2039		201	347	-	3,022	3,569	8,093	396	371	8,860	5,290
2039	2040		201	364	-	3,197	3,762	8,779	416	380	9,575	5,813
2040	2041		201	3,045	-	3,383	6,629	9,523	437	390	10,349	3,720
2041	2042		201	903	5,349	3,692	10,144	10,249	458	400	11,107	962
2042	2043		201	249	-	3,906	4,355	11,030	481	410	11,921	7,565
2043	2044		201	261	-	4,133	4,595	11,871	505	420	12,796	8,201
2044	2045		201	274	-	4,375	4,851	12,777	531	430	13,738	8,887
2045	2046		201	5,841	-	4,633	10,675	13,752	557	441	14,750	4,075
2046	2047		201	1,152	-	4,907	6,260	14,801	585	452	15,839	9,578
2047	2048		201	348	-	5,199	5,748	15,932	614	463	17,009	11,262
2048	2049		201	365	-	5,510	6,076	17,149	645	475	18,269	12,193
2049	2050		201	383	-	5,841	6,425	18,459	677	487	19,623	13,199
2050	2051			6,207	-	6,193	12,400	19,870	711	499	21,080	8,680
2051	2052			1,415	-	6,568	7,983	21,390	747	512	22,648	14,664
2052	2053			1,943	5,718	7,069	14,730	23,026	784	524	24,334	9,604
2053	2054			1,560	-	7,499	9,059	24,787	823	537	26,148	17,089
2054	2055	(7,075)		1,638	-	7,956	2,519	26,685	864	551	28,100	25,581
		55,176	5,027	29,131	11,961	111,725	213,019	328,874	13,718	11,818	354,410	141,390
											IRR	5.84%

EXHIBIT VI – Project Equity FIRR over 30-year Stream (INR in Crores)

Year		Capital Outlay	Land - JDA Outlay	O & M Expenditure	Repalcement Cost	Additional CAPEX	Total Cash Outflows	Fare Box Revenues	Non Fare Box Revenues	VCF Revenues	Total Revenues	Loan Funds	IDC	Loan Repayment	Forex Fluctuation	Principal	Interest	Outstanding Principal	Subordinate Debt	Subordinate Debt Repayment	Net Cash Inflow/ (Outflow)
														36,238.58	3%						
2020	2021	1,620	-	-	-	-	1,620	-	-	-	-	-	-		-			-	1,368	-	(253)
2021	2022	11,049	-	-	-	-	11,049	-	-	-	-	3,216	3		48			3,264	5,645	-	(2,187)
2022	2023	15,879	-	-	-	-	15,879	-	-	-	-	7,459	14		210			10,933	5,319	-	(3,101)
2023	2024	15,515	-	-	-	-	15,515	-	-	-	-	10,474	32		485			21,892	2,204	-	(2,837)
2024	2025	13,021	-	-	-	-	13,021	-	-	-	-	9,003	51		792			31,687	1,634	-	(2,384)
2025	2026	5,168	201	1,263	-	-	6,632	2,513	149	269	2,931	3,548	64		1,004			36,239	881	-	729
2026	2027	-	201	1,333	79	-	1,613	2,774	167	276	3,217			(1,946)	(58)	1,873	72	34,365	201	-	(199)
2027	2028	-	201	1,407	83	-	1,691	3,062	187	283	3,531			(1,946)	(118)	1,877	69	32,488	201	-	(23)
2028	2029	-	201	1,486	87	-	1,774	3,373	208	290	3,871			(1,946)	(180)	1,881	65	30,608	201	-	172
2029	2030	-	201	1,600	92	894	2,786	3,717	230	297	4,245			(1,946)	(244)	1,884	61	28,723	201	-	(530)
2030	2031	-	201	1,689	103	-	1,993	4,097	255	305	4,657			(1,946)	(310)	1,888	57	26,835	201	-	609
2031	2032	-	201	1,779	108	-	2,088	4,470	281	312	5,064			(1,946)	(378)	1,892	54	24,943	201	-	853
2032	2033	-	201	1,880	113	-	2,195	4,878	295	320	5,494			(1,946)	(447)	1,896	50	23,047	201	-	1,107
2033	2034	-	201	1,988	119	-	2,308	5,324	310	328	5,962			(1,946)	(519)	1,900	46	21,148	201	-	1,390
2034	2035	-	201	2,102	160	-	2,464	5,811	326	336	6,472			(1,946)	(593)	1,903	42	19,244	201	-	1,671
2035	2036	-	201	2,556	1,265	-	4,022	6,343	342	345	7,029			(1,946)	(669)	1,907	38	17,337	201	-	594
2036	2037	-	201	2,702	306	-	3,208	6,879	359	353	7,591			(1,946)	(748)	1,911	35	15,426	201	-	1,891
2037	2038	-	201	2,857	321	-	3,379	7,461	377	362	8,200			(1,946)	(828)	1,915	31	13,511	201	-	2,248
2038	2039	-	201	3,022	347	-	3,569	8,093	396	371	8,860			(1,946)	(912)	1,919	27	11,593	201	-	2,634
2039	2040	-	201	3,197	364	-	3,762	8,779	416	380	9,575			(1,946)	(997)	1,922	23	9,670	201	-	3,071
2040	2041	-	201	3,383	3,045	-	6,629	9,523	437	390	10,349			(1,946)	(1,086)	1,926	19	7,744	201	-	890
2041	2042	-	201	3,692	903	5,349	10,144	10,249	458	400	11,107			(1,946)	(1,177)	1,930	15	5,814	201	-	(1,959)
2042	2043	-	201	3,906	249	-	4,355	11,030	481	410	11,921			(1,946)	(1,270)	1,934	12	3,880	201	-	4,551
2043	2044	-	201	4,133	261	-	4,595	11,871	505	420	12,796			(1,946)	(1,367)	1,938	8	1,942	201	-	5,090
2044	2045	-	201	4,375	274	-	4,851	12,777	531	430	13,738			(1,946)	(1,466)	1,942	4	-	201	-	5,677
2045	2046	-	201	4,633	5,841	-	10,675	13,752	557	441	14,750								201	(2,188)	2,089
2046	2047	-	201	4,907	1,152	-	6,260	14,801	585	452	15,839								201	(2,188)	7,592
2047	2048	-	201	5,199	348	-	5,748	15,932	614	463	17,009								201	(2,188)	9,275
2048	2049	-	201	5,510	365	-	6,076	17,149	645	475	18,269								201	(2,188)	10,207
2049	2050	-	201	5,841	383	-	6,425	18,459	677	487	19,623								201	(2,188)	11,212
2050	2051	-	-	6,193	6,207	-	12,400	19,870	711	499	21,080								-	(2,188)	6,492
2051	2052	-	-	6,568	1,415	-	7,983	21,390	747	512	22,648								-	(2,188)	12,476
2052	2053	-	-	7,069	1,943	5,718	14,730	23,026	784	524	24,334								-	(2,188)	7,416
2053	2054	-	-	7,499	1,560	-	9,059	24,787	823	537	26,148								-	(2,188)	14,902
2054	2055	(7,075)	-	7,956	1,638	-	2,519	26,685	864	551	28,100								-	(2,188)	23,393
		55,176	5,027	111,725	29,131	11,961	213,019	328,874	13,718	11,818	354,410	33,700	164	(36,968)		36,239	729	432,334	21,877	(21,877)	124,755
																		IRR			11.5%

EXHIBIT VII – Project Equity FIRR over 30-year Stream to the Private Concessionaire on DBFOT basis. (INR in Crores)

Year		Capital Outlay	VGF by GOI/ Railways (20%)	VGF by GOK (20%)	O & M Expenditure	Repalcement Cost	Additional CAPEX	Total Cash Outflows	Fare Box Revenues	Non Fare Box Revenues	Total Revenues	Loan Funds	IDC	Loan Repayment	Principal	Interest	Outstanding Principal	Net Cash Inflow/ (Outflow)
			20%	20%										39,420.99				
2020	2021	1,855	(371)	(371)	-	-	-	1,113	-	-	-	890	45				935	(223)
2021	2022	11,868	(2,374)	(2,374)	-	-	-	7,121	-	-	-	5,697	374				7,006	(1,424)
2022	2023	16,481	(3,296)	(3,296)	-	-	-	9,889	-	-	-	7,911	1,054				15,971	(1,978)
2023	2024	15,515	(3,103)	(3,103)	-	-	-	9,309	-	-	-	7,447	1,822				25,240	(1,862)
2024	2025	13,021	(2,604)	(2,604)	-	-	-	7,812	-	-	-	6,250	2,507				33,997	(1,562)
2025	2026	5,168	(1,034)	(1,034)	1,263	-	-	4,363	2,513	149	2,662	2,481	2,944				39,421	779
2026	2027	-	-	-	1,333	79	-	1,412	2,774	167	2,941			(4,713)	771	3,942	38,650	(3,184)
2027	2028	-	-	-	1,407	83	-	1,490	3,062	187	3,248			(4,713)	848	3,865	37,803	(2,955)
2028	2029	-	-	-	1,486	87	-	1,573	3,373	208	3,581			(4,713)	932	3,780	36,870	(2,705)
2029	2030	-			1,600	92	894	2,585	3,717	230	3,948			(4,713)	1,026	3,687	35,845	(3,350)
2030	2031	-			1,689	103	-	1,792	4,097	255	4,352			(4,713)	1,128	3,584	34,717	(2,153)
2031	2032	-			1,779	108	-	1,887	4,470	281	4,752			(4,713)	1,241	3,472	33,476	(1,848)
2032	2033	-			1,880	113	-	1,994	4,878	295	5,174			(4,713)	1,365	3,348	32,111	(1,533)
2033	2034	-			1,988	119	-	2,107	5,324	310	5,634			(4,713)	1,502	3,211	30,609	(1,186)
2034	2035	-			2,102	160	-	2,263	5,811	326	6,136			(4,713)	1,652	3,061	28,957	(839)
2035	2036	-			2,556	1,265	-	3,821	6,343	342	6,685			(4,713)	1,817	2,896	27,140	(1,849)
2036	2037	-			2,702	306	-	3,007	6,879	359	7,238			(4,713)	1,999	2,714	25,142	(482)
2037	2038	-			2,857	321	-	3,178	7,461	377	7,838			(4,713)	2,198	2,514	22,943	(52)
2038	2039	-			3,022	347	-	3,368	8,093	396	8,489			(4,713)	2,418	2,294	20,525	408
2039	2040	-			3,197	364	-	3,561	8,779	416	9,194			(4,713)	2,660	2,052	17,865	921
2040	2041	-			3,383	3,045	-	6,428	9,523	437	9,959			(4,713)	2,926	1,786	14,938	(1,182)
2041	2042	-			3,692	903	5,349	9,943	10,249	458	10,707			(4,713)	3,219	1,494	11,720	(3,949)
2042	2043	-			3,906	249	-	4,154	11,030	481	11,511			(4,713)	3,541	1,172	8,179	2,644
2043	2044	-			4,133	261	-	4,394	11,871	505	12,376			(4,713)	3,895	818	4,284	3,269
2044	2045	-			4,375	274	-	4,650	12,777	531	13,307			(4,713)	4,284	428	0	3,945
2045	2046	-			4,633	5,841	-	10,474	13,752	557	14,309							3,835
2046	2047	-			4,907	1,152	-	6,059	14,801	585	15,386							9,327
2047	2048	-			5,199	348	-	5,547	15,932	614	16,546							10,999
2048	2049	-			5,510	365	-	5,875	17,149	645	17,794							11,919
2049	2050	-			5,841	383	-	6,224	18,459	677	19,137							12,913
2050	2051	-			6,193	6,207	-	12,400	19,870	711	20,581							8,181
2051	2052	-			6,568	1,415	-	7,983	21,390	747	22,136							14,153
2052	2053	-			7,069	1,943	5,718	14,730	23,026	784	23,810							9,079
2053	2054	-			7,499	1,560	-	9,059	24,787	823	25,611							16,552
2054	2055				7,956	1,638	-	9,595	26,685	864	27,549							17,954
		63,908	(12,782)	(12,782)	111,725	29,131	11,961	191,161	328,874	13,718	342,592	30,676	8,745	(89,540)	39,421	50,119	584,343	92,566
																	IRR	6.77%

DETAILED PROJECT REPORT

SEMI HIGH SPEED RAIL CORRIDOR
THIRUVANANTHAPURAM TO KASARAGOD

VOLUME II - MAIN REPORT
(PART D)

CHAPTER 20
SUSTAINABLE TRANSPORT SYSTEM & GREEN INITIATIVES

20 SUSTAINABLE TRANSPORT AND GREEN INITIATIVES

20.1 INTRODUCTION

Historically, sustainability has been a way of living. With the intent of progressing and developing the world, extensive use of resources took place and newer interventions were made to enhance the rate at which the advancement was happening. The effects of climate change became apparent soon thereafter in terms of rising temperatures and frequent incidences of natural calamities. As a result of all the environmental mayhem, the sustainable development goals (SDGs) were set and came into effect in January 2016.

To align with the global agenda and moving towards sustainability, several industries have been self-declaring to be sustainable by adopting greener practices. Sustainability was initially demonstrated as an environmental concept but over the years it has undergone a massive paradigm shift. It has been fully integrated into the way we think and plan our economic goals. In order to address the challenges faced by humanity, it is imperative to strike a balance between social development, sustained economic growth, sustainable management of natural resources and cultural variations. By focusing only on the economic growth and neglecting the other aspects would lead to short term growth but would eventually have irreversible consequences.

Keeping this in mind the integrated approach for sustainability becomes extremely important. The sustainability goals can thus be met by enhancing resource efficiencies and minimal waste generation without impacting the environment. Additionally, the intent is also to work symbiotically and ensure that the waste generated in one process becomes a resource for the other process thus creating a closed loop.

India had participated the following two important international United Nations (UN) conferences. India is also a signatory of these UN declaration for safeguarding the environment and sustainable development.

1. United Nations conference on the Human Environment (1972), Stockholm
2. United Nations Conference on Environment and Development (1992), Rio de Janeiro (also known as the World Earth Summit)

India was also a participant and signatory of the Kyoto Protocol, which prescribes emission standards and greenhouse gas emission reduction. The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change (UNFCCC), which commits its Parties by setting internationally binding emission reduction targets.

In line with the national and international goals, K-Rail is committed to implement the concepts of environmental protection, sustainable development, sustainable transport, emission reduction and energy efficiency in this SilverLine.

20.2 SUSTAINABLE DEVELOPMENT

The concept of "Sustainability" is one of the most hot topics related to the technological development in the modern era. It aims to satisfy the present needs without compromising the needs of next generations.

Environmental Sustainability has been defined by the United Nations in 2005 as: "Meeting the needs of the present without compromising the ability of future generations to meet their needs. Encompasses, e.g. facilitating the renewal of renewable resources, conserving and establishing priorities for the use of non-renewable resources, keeping population densities below the carrying capacity of a region, and keeping environmental impact below the level required to allow affected systems to recover and continue to evolve".

In order to guarantee a sustainable environmental development, a set of sustainable environment indicators has been considered, which can generally be understood as tools that analyse changes, while measuring and communicating progress towards the sustainable use and management of environmental resources.

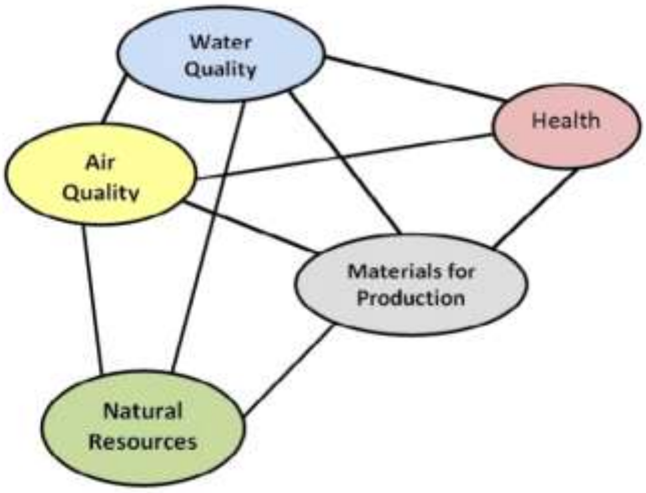


Figure 20-1: Indicators of Environmental Sustainability

An indicator complies must be compliant to the following

- Specificity (it must relate to the desired outcome, i.e. fit the purpose for measuring)
- Measurability (it should preferably be open to measurement in a quantitative manner);
- Sensitivity (it must readily change as circumstances change);
- Reliability (The information that an indicator is providing must be reliable. Data upon which the indicator is based must therefore be collected using a systematic method).

Now a days, it's proved that each of these indicators is also dramatically affected by the contribution of transportation. As per WHO study, transport sector accounted for about 23% of global carbon dioxide emissions in 2010 and 27% of end-use energy emissions

with urban transport accounting for about 40% of end-use energy consumption, on other hand only 2% of this amount is caused by rail transport as per study conducted by CPCB, Delhi.

Since train can be considered the major transport mode of the future, leading international organizations like UIC work for a continuous upgrading of sustainable rail transportation, in order to guarantee the best quality of life.

K- Rail proposes to build this SilverLine rail corridor as a Sustainable Transport. Hence this project is committed to develop an environmentally- and economically sustainable, long-term alternative to the current transportation systems in Kerala, which will increase transportation efficiency, use 100 percent renewable energy, and incorporate additional sustainability practices.

20.3 GUIDELINES FOR SUSTAINABLE TRANSPORT- AVOID, SHIFT, AND IMPROVE STRATEGY

There are three primary strategy responses to the challenge of reducing the environmental impact of transport (Dalkmann and Brannigan, 2007): Avoid, Shift, Improve. For sustainable development, first commutation should be avoided. If it cannot be avoided, then there should be a shift to sustainable public transport system. If there is no sustainable public transport system, then strategy must be there to improve public transport to make it sustainable. K- Rail is planning to attain the sustainable transport considering these pillar ideas.

20.3.1 Avoid

Limiting the transport demand can be obtained by enforcing quota systems, by creating transport alternatives or by reducing the transport needs. Digital revolutions play a significant role in communicating people without movement. When implementation of the semi high speed network boosts better land use through the relocation of housing, commercial and industrial real estate, the reorganisation of the local urban transports, or the promotion of new ways of life. The creation of co-working spaces in new stations illustrates this last aspect, while also providing access to a wide range of services and shop facilities.

20.3.2 Shift

The advantages of SilverLine in terms of energy consumption and Green House Gas (GHG) emissions, compared to its competitors, are one of the main drivers for reducing the carbon footprint of the transport sector. A UIC study on HSR in France and China concluded that the carbon footprint of HSR can be up to 14 times less carbon intensive than car travel and up to 15 times less than aviation travel, even when measured over the full life cycles of planning, construction and operation of the different transport modes. As a result, shifting passengers to high speed rail from air and road transport reduces CO_2 emissions. Expectations of a mode shift to rail regarding the corresponding CO_2 reductions have been proven by experience across a very large number of corridors.

20.3.3 Improve

Since 1964, HSR has constantly introduced improvements and innovations aimed at reducing high speed rail externalities: vibrations, noise, CO_2 emissions, etc. Much has also been done to recycle infrastructure and rolling stock components. Energy efficiency is at the heart of the problem. Numerous measures have been taken to :

- build lighter vehicles;
- streamline trains;
- increase on-board seat capacity;
- introduce energy regenerative systems;
- increase the share of renewable energies;
- improve all ancillary systems such as air conditioning or lighting; etc.

Paradoxically, the energy consumption per passenger of high speed trains is usually lower than that of conventional trains running between the same stations, according to several parameters such as a more homogeneous speed profile.

20.4 K- RAIL CORPORATE ENVIRONMENT POLICY

K- Rail and the SPV (Special Purpose Vehicle) to be constituted under K- Rail for execution and operation of this project may adopt a suitable Environment Policy for the commitment to integrate environmental protection and social development in its mandates, in a proactive manner, to contribute towards sustainable development. To achieve the fine balance among developmental imperatives and environmental wellbeing. K-Rail gives due importance to environmental considerations in adopting the projects to minimize adverse impacts and risks to the environment and people that may be affected.

K- Rail is very much concerned to environmental issues, commitment towards compliance, and responsiveness towards environmental requirements of its projects.

The Environment Policy proposed basically may cover the following.

- Sustainable development for inclusive growth as the key objective of the national economy to adopt an environment friendly mode of transport system
- To exhibit sensitivity towards environmental responsibilities and conduct our activities
- Efficient utilization of energy resources.
- Associate in direct activities towards environmental improvement through development of green belt and conservation of water resources.
- Make efforts for preservation of ecological balance & heritage.
- Mitigation measures for noise, vibration and waste pollution.
- Sensitize human resource of the corporation towards environmental needs.
- Sustain improvement of environmental performance of the organization.
- compliance of all regulations and guidelines relating to environment.

20.5 ENVIRONMENTAL FRAMEWORK

The Environmental Management Framework addresses following key issues

- to avoid and to minimize adverse environmental impacts/risks due to project,
- to ensure that adverse environmental impacts/risks are well mitigated/ minimized to achieve applicable environmental standards and objectives,
- to comply with applicable central and state government laws and regulations, and environmental safeguards requirements of development partners,
- to provide guidance to its own staff in conducting subsequent monitoring & reporting, and in undertaking corrective actions;
- To develop and exercise mechanisms for effective supervision by K-Rail during implementation.

Guidelines for the K-Rail in terms of for environmental regulations and its implementation for future projects.

For better understanding the Environmental Management Framework, EMF is divided into three parts:

- Environmental Management Regulatory Procedure (EMRP)
- Capacity Building Plan (CBP)
- Environmental Code of Conduct (ECoC)

Figure 20-2: Environmental Management Framework

20.6 COLLABORATION WITH INDIAN INSTITUTE OF MANAGEMENT (IIM). AHMEDABAD

K- Rail is proposing to develop a sustainability policy in collaboration with Indian Institute of Management (IIM)- Ahmedabad, which is a world-renowned institute and other nodal agencies. A preliminary meeting was held with IIM - Ahmedabad and the basic modalities

are being worked out. More initiative to be launched and finalised to make the basic framework and policies to be adopted.

20.7 SUSTAINABLE TRANSPORTATION IN SILVERLINE

The objective of SilverLine for sustainable transport system includes :

- Allows the basic access and development needs of individuals
- Supports safety and human health
- Promotes equity within and between successive generations
- Is affordable, fair and efficient
- Offers choice of transport mode
- Supports a competitive economy and balanced regional development
- Limits emissions and waste within the planet’s ability to absorb them
- Uses resources at rates which permit renewal or substitution
- Minimises impacts on the use of land and the generation of noise.

This project is committed to develop an environmentally and economically sustainable, long term alternative to the current transportation systems in Kerala, which will increase transportation efficiency, use 100 percentage of renewable energy and incorporate additional sustainability practices.

Although rail is one of the world’s oldest transportation methods, it continues to be one of the most energy efficient ways to move large number of people. Experience both in India and abroad illustrate that rail travel provides an efficient alternative for the traveller, who wants to reach key, central destinations and important cities without the delay and hassle of air travel, and in a faster, less polluting, safer and more efficient method than driving.

As per traffic study conducted by K-Rail, in 2025, it is estimated that 79,934 passengers will use SilverLine corridor between Thiruvananthapuram and Kasaragod, which requires approximately 279 million units of energy. In 2052, approximately 497 million units of energy will be required to transport 1,58,946 passengers among the stations between Thiruvananthapuram and Kasaragod.. The energy required to move similar numbers of passengers by car would be thrice the energy required for SilverLine.

Energy - efficiency and maximizing recovery of electricity are just part of the plans. In 2025, it is proposed to adopt a policy goal to run operations with 100 percentage of renewable energy. Through proper planning and co-ordination with utility companies and regulatory agencies, it is proposed to achieve this goal to procure or producing enough renewable energy to feed into the grid to offset the amount the train uses.

This net zero approach means that renewable energy developers can find the most economical locations to develop and distribute energy to the grid. Simultaneously, through a formal call to industry process, it is proposed to ascertain the capacity, and the strong interest companies, to provide renewable energy to the system. In addition, it is

being explored to produce solar or other renewable energy generation on semi high speed rail canopies, roof and maintenance facilities as well as other structures.

In this fashion, the SilverLine will be ahead of the clean transportation curve and leading by example.

20.7.1 Rail as Energy Efficient Transport

Rail is a low carbon mode, a very safe transport mode, a very resource efficient mass transport system compared to other modes. It has an important social and economic role. It is key to a solution to traffic congestion, movement of freight etc.

A sustainable transport system combines the strengths of all transport modes in one integrated system. Rail can be the leader for such intermodal transport system. This corridor is designed as such towards sustainable transport.

The present SilverLine is proposed to meet the following :

- **A SUSTAINABLE MODE OF TRANSPORT**
  - Has a lower impact on climate and environment than all other compatible transport modes.
    - ✓ Energy consumption and GHG emissions
    - ✓ Air pollution
    - ✓ Noise and Vibration
    - ✓ Resource efficiency (material use)
    - ✓ Biodiversity
    - ✓ Visual insertion
    - ✓ Land use
  - The safest transport mode
  - Relieves roads and reduces congestion
- **AN ATTRACTIVE TRANSPORT MODE**
  - increases quality and productive time
  - provides reliable and comfort mobility
  - improves access to mobility
- **CONTRIBUTES TO SUSTAINABLE ECONOMIC DEVELOPMENT**
  - provides macro-economic advantages despite its high investment costs
  - has lower external costs than competitive modes
  - contributes to local development
  - provides green jobs
  - act responsibly and improve sustainability

20.7.2 Carbon Balance Of High-Speed Train

Semi High-speed Rail projects are usually appraised by means of two important criterion to balance namely, economic and environmental. The environmental balance spans the life cycle of the infrastructure from the very first design to final recycling of its components, through the construction and operation periods. This means that the footprint includes the carbon emissions when:

- designing the line, because the engineers and draftsmen will need buildings and devices to shelter them and provide comfort and heating or air conditioning, fuel for going in the field or to meetings, etc.;
- constructing the line, the stations and the rolling stock,
- including the emissions for extracting and shaping materials (e.g. steel or cement), and for their transport (e.g. moving the earth or transporting the rails);
- operating trains and stations;
- maintaining the infrastructure and the rolling stock;
- distributing tickets;
- recycling the components of the infrastructure and the rolling stock.

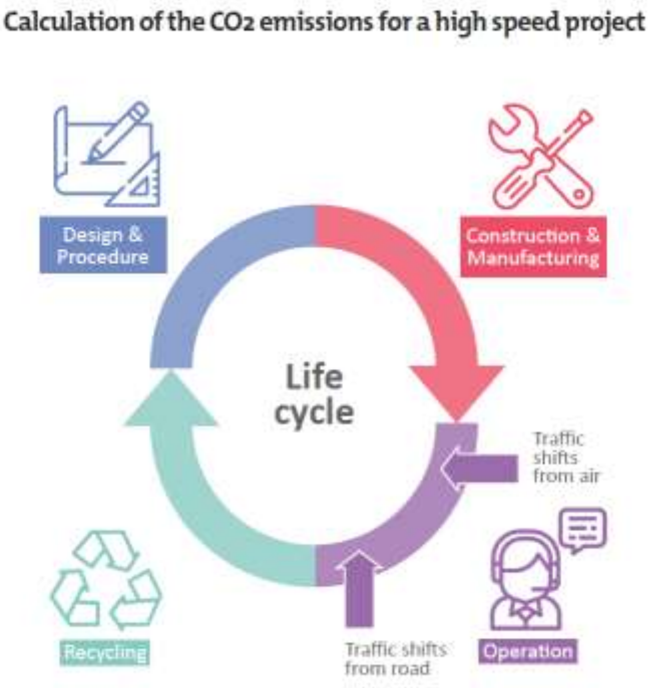


Figure 20-3: Calculation of CO_2 emissions for high speed project

It is clear that, all these emissions lead to a substantial footprint spread along the life of the project (from 50 to 100 years), but this is strongly concentrated at the beginning of the period due to the impact of construction. For example, in the case of a 300-km long HSR line, the CO_2 emissions amount to 1.5 million tonnes. However, these emissions are offset during the revenue period because of the CO_2 savings due to the traffic shift from road (50,000 tonnes per year) and air (80,000 tonnes per year) to rail. This means that the carbon balance, which is heavily negative at the end of the construction period, improves year on year of operation.

Therefore, a high-speed rail line project is only environmentally feasible if there is a strong certainty that the traffic diversion volumes will be significant. This is even more important where there are predictions of changes to the technology of all transport modes, such as cars, and even aero planes, powered by electricity.

UIC data on the comparison of CO_2 emission and energy consumption by different mode of transport is shown below.

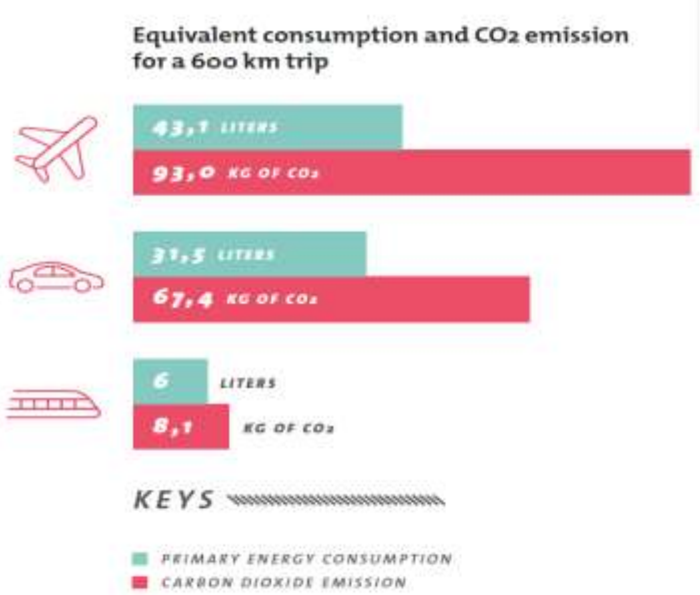


Figure 20-4: CO_2 emission in various transport system

20.7.3 Mode Shift Resulting in Energy Efficiency and Emission Reduction

So, what's the bottom line for high-speed rail as it relates to-energy future?

Starting in 2025, during the system's first year of operation, K- Rail anticipates a ramp-up in usage as travellers begin to make the switch from driving or flying to taking high-speed rail. Every subsequent year, as the system is projected to increase riders, it is expected continued reductions in GHG emissions as well as criteria air pollutants.

Cumulatively by 2029-30, the semi high-speed rail system will reduce 1.2 million tons of carbon dioxide equivalent (mmtCO_2e) and by 2050, the system will reduce minimum 10 million tons of CO_2e.

20.8 MEASURES FOR SUSTAINABLE TRANSPORT IN SILVERLINE

Multiple and proven solutions to achieve the sustainable transportation in SilverLine project is being proposed in this section.

20.9 ENVIRONMENT CONSIDERATION AND PRESERVATION

20.9.1 EIA Study

EIA study is being conducted, to evaluate the impact on the habitat of water bodies, wildlife, flora & fauna and for the probable impact of air, water and soil pollution. Strict mitigation measures are proposed to be taken based on the report.

20.9.2 Land and Water Body Preservation

Compared to other mode of transport, due its high passenger capacity, the land needed for semi high speed rail project for the large traffic volumes carried is much reduced. An average high-speed rail line uses 3.2 Ha/km and an average motor way uses 9.3 Ha/km.

Similarly, the semi high speed rail infrastructure requirements such as curves and gradients are optimized based on global practices to reduce the land requirement. The land proposed to be used in this corridor is approximate between 2.06-2.44 Ha/km, which is much less than the motor way.

20.9.2.1 Topsoil Preservation

"Top soil is the top layer of soil, in which all plants grow. Topsoil is so important because it contains all the nutrients that plants need to survive".

While conducting construction operations at sites special care will be taken care to preserve precious top soil .Top soil being rich in organic nutrients that fit for plant growth and survival. Following practices are proposed to avoid wastage.

- Top soil is collected and preserved at designated place in situ with the help of Tarpaulin.
- The stockpiles being designed such that the slope does not exceed 1:2 (vertical to horizontal) and the height of the pile to be restricted to 2 m.
- After borrowing of earth material, preserved top soil is spread over the borrowed land to restore its productivity.
- The top soil being utilized for redevelopment of borrow areas, landscaping along slopes, incidental spaces etc.
- Incorporation of suitable and effective contractual clauses for rehabilitation and restoration of borrow areas and other temporary works and landscaping it with surrounding area immediately after its use.

	
Top Soil Stockpiling	Top Soil Stacking

Figure 20-5: Topsoil Stacking

Figure 20-6: After Backfilling Topsoil Closed Borrow Area

20.9.2.2 Protection of Paddy Field and Agricultural Land

Paddy fields are considered to be the air coolers of Earth, reducing the Carbon-Dioxide in the atmosphere and store it in the form of Carbon. Paddy fields thus helps to preserve Earth from hazards of Carbon-Dioxide.

In view of the importance of paddy cultivation, Government of Kerala also have launched a program for Reviving of Paddy Forming duly allocating a separate fund and set up a separate executing organization. K- Rail has already associating and coordinating with this program. Necessary assistance of this agency and the special fund can also be taken to revive the damages to paddy fields and convert the follow land (due to the construction of this project) to green paddy fields.

Out of the total land requirement of 1343 Ha for this project, the paddy field land used is 253.45 Ha, which is only 18.9%. Out of 253.45 Ha of paddy land used, approximately 30 Ha will be redeveloped and reclaimed as paddy field and in addition approximately 10 Ha of follow land will be converted as paddy field.

The 15% of net paddy field agricultural land will come down after the follow land is converted into paddy field at the end of the project.

20.9.2.3 Protection of Agricultural Land while movement of construction vehicle on haul road

For suppressing the effect of generated dust on standing crop due to movement of construction vehicle on haul road, along with regular water sprinkling Green Net along agricultural farm is proposed to be provided. Extra precautions are being taken care of

as second layer of protection to safeguard the effect of dust generated on agricultural land from vehicle plying on road.

(a) Haul Road Definition: A Haul road is a term for roads designed for heavy or bulk transfer of construction materials by haul trucks in the vicinity of railway project. Such situation will be monitored.

(b) Water Body Conservations: Care has been taken while fixing the alignment to minimize the disturbance to water bodies and the free flow of water.

(c) Bottom Sediments: Silt fencing will be provided to avoid runoff into the river and to save water quality of water body. Care will be taken to avoid spreading of construction material and minimize impact on water quality.

20.10 ENVIRONMENTAL PROTECTION DURING CONSTRUCTION

Strategies proposed to be adopted during construction include items such as requirements for recycling all steel and concrete; diversion of construction waste from landfills through reuse and recycling; use of new, low emission construction equipment and replacement of inefficient truck engines and irrigation pumps.

20.11 FOREST AND ECOLOGY PRESERVATION

20.11.1 Avoiding Ecologically Sensitive Areas While Routing Lines

Kerala is one of the few States in India is provided with rich in Forest cover including virgin forests, Ecological sensitive areas, Flora and Fauna, Wildlife Sanctuaries, Biospheres. A highly sensitive very long coastal zone is also available. Though the geography is such that on one side it is the high mountain contains the sensitive forest ecology, the other side it is the fragile coastal region and, in the middle, thickly populated area,

Environmentally proactive approach has been taken in finalizing the alignments in such a way to avoid or minimize damage to the environment by avoiding of sensitive forest land and passing through wild life sanctuary and also the coastal zone. The alignment is not passing through any reserve forest, or near wildlife sanctuary.

Though Kerala has nearly 30 % age of total area as forest area, no forest land has been used for this project by careful planning, though the proposed rail corridor covers almost entire Kerala North to South.

20.11.2 Forestry Development

It is a necessary evil and unavoidable to cut or replant trees during any major construction like railway project. In this project, ten trees will be planted for every tree getting cut. In this way more trees will come up and hence the greenery.

20.12 NOISE

Noise disturbances as well as vibrations are important issues when examining sustainable transport. Millions of people are affected by noise, especially traffic noise.

Rail noise impacts tend to be limited to people living along rail network routes, and so affects far fewer people compared road noise.

20.12.1 Noise Limit

During construction and operation, the noise level will be within the limits prescribed by the standards and codes. Necessary noise limit clause will be incorporated in the specifications of the Equipment like Rolling Stock etc.

20.12.2 Installing Noise Barrier near Sensitive Receptor

School, Hospitals, Mandir, Masjid close to the track (within 20 m from ROW) are the primarily susceptible site for high noise level. It is proposed to safeguard sensitive receptor from high noise. Noise mitigation measures in the form of noise barrier at sensitive receptors will be provided during construction & operation phase of the semi HSR corridor . This will be included in the Contracts.

20.13 GREEN CONSTRUCTION

During construction the air, water and noise pollution is to be minimum and no waste or sewerage will be discharged in the water bodies. Noise level will be kept minimum and within limits by suitable measurement and preventing methods.

20.14 GREEN INITIATIVES

20.14.1 Green Building

There is a growing focus on reducing carbon emissions through sustainable buildings. The 2008 National Action Plan for Climate Change includes the National Commission on Enhanced Energy Efficiency which includes the promotion of energy efficiency in building. Whilst the sector is not underpinned by regulation, the government has announced several initiatives such as the Green Rating for Integrated Habitat Assessment (GRIHA) introduced by the Ministry of New and Renewable Energy.

Green buildings are designed to reduce the overall impact of the built environment on human health and natural environment by:

- Efficiently using energy, water and other resources.
- Protecting occupant’s health and improving employee productivity.
- Reducing waste, pollution and environment degradation.

The pictorial representation is illustrated in figure 20-7.

Figure 20-7: Sustainable Green Building

Following can be considered for green buildings:

- Sustainable Architecture and Design
- Green buildings may incorporate sustainable materials in their construction (e.g., reused, recycled content, or made from renewable resources).
- Create healthy indoor environments with minimal pollutants (e.g., reduced product emissions).
- Water Conservation and feature landscaping that reduce water usage (e.g., by using native plants that survive without extra watering).
- Energy Efficiency
- Indoor Environmental Quality
- A green building is a structure that is environmentally responsible and resource-efficient throughout its life-cycle. These objectives expand and complement the classical building design concerns of economy, utility, durability and comfort.

Green Features of a Green Building:

- Minimal disturbance to landscapes and site condition
- Use of non-toxic and recycled / recyclable material
- Efficient use of water and water recycling
- Use of energy efficient and eco-friendly equipment
- Use of renewable energy
- Quality of indoor air quality for human safety and comfort
- Effective controls and building management systems.

The features must comprise in Green Building is shown in Figure 20-8.

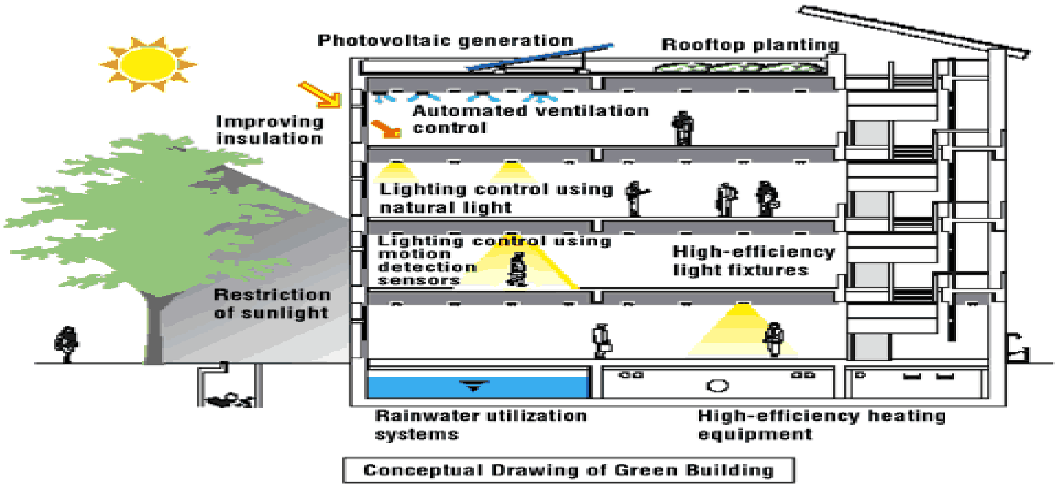


Figure 20-8: Green Building Features

Indian Green Building Council (IGBC) Green Railway Stations

CII-IGBC with the support of Environment Directorate of Indian Railway has developed the Green Railway Stations rating system. IGBC Green Railway Stations rating system is a voluntary and consensus-based program.

IGBC Green Railway Stations rating system is the first of its kind holistic rating in India to address environmental sustainability in Indian railway stations. The overarching objective of the rating is to facilitate adoption of green concepts, thereby reduce the adverse environmental impacts due to station operation & maintenance and enhance the overall commuter experience at station. The rating system will help the station management to understand their present position with respect to the 'green performance' of the station and the measures that need to be taken to enhance the performance on a continual basis.

Green Railway Stations Benefits

By applying the green concepts in the design & construction, the following benefits are envisaged over conventional railway station.

Indian Railways:

- Operational savings through reduction in electrical energy consumption towards non-traction upto 40%
- Water consumption reduction for station applications upto 30%
- Effective Waste management during operation of station
- Improved station facility management
- Opportunity to increase environmental awareness among all Indian Railways staff

Commuters:

- Improved accessibility to stations, thereby enabling easier first mile & last mile connectivity
- Effective ventilation & indoor environment quality
- Enhanced health, well-being & safety of commuters
- User-friendly design for differently abled & elderly people

Other Environmental Benefits:

- Reduction in energy consumption and hence the reduction in the associated environmental impacts.
- Increased use of renewable energy sources, thereby minimizing the fossil fuel energy use
- Improved waste management, thereby avoiding waste being sent to land-fills
- Use of eco-friendly construction materials thereby reducing the dependency on the use of virgin materials

Building construction and operation have an enormous direct and indirect impact on the environment. Buildings use vast amounts of energy and raw materials and produce waste and harmful emissions to the environment. Typical buildings in earlier decades were big users of chlorofluorocarbons (CFC) that degrade the ozone layer, and fossil fuels that emit greenhouse gases.

Smart architects think rationally about issues as sustainability, durability, longevity, using appropriate materials and the efficient use of space. This is not just locally or nationally, but there is an increasing recognition internationally in working with sustainable building or green building.

Sustainable buildings are structures that are built in an environmentally responsible manner by maximizing use of materials, minimizing use of resources and ensuring the health and well-being of occupants and the surrounding built environment both today and for generations to come. It is the practice of increasing the efficiency with which buildings and their sites efficiently use energy, water and material, and reducing building impacts on human health and the environment through better siting, design, construction, operation, maintenance and removal.

In this corridor, the Station buildings, depot, administrative building and other service buildings are designed based on the platinum rating standard of Indian Green Building Council (IGBC). Necessary certificate will be obtained at the time of construction and operation.

SilverLine Green Building Initiatives:

In view of above concept, following buildings models will be proposed for corridor as mentioned in indicative pictures,

Figure 20-9: Image of Station Buildings

Figure 20-10: Façade Image of the SilverLine Station

Figure 20-11: Image of a Windscreen

Figure 20-12: Image of Ticket Counters

Figure 20-13: Image of Commercial Zone in the Free Concourse Area

Figure 20-14: Image of Waiting Room for Second Class Passengers

20.14.2 Green Energy (100%)

This project is proposed to be 100% powered by renewable energy sources mainly solar power supplemented by the other form of renewable sources like wind to make it as a green energy and sustainable transport project.

20.14.3 Models adopted for Renewable Energy

There are different types of execution models available in India:

20.14.3.1 RESCO Model

A Renewable Energy Service Company (RESCO) is an Energy service company, which provides energy to the consumers from renewable energy sources, usually solar photovoltaics, wind power or micro hydro.

The main characteristics of a RESCO are:

- The household serviced does not own the generation equipment, which is owned by an external organization (RESCO)
- The user does not carry out maintenance, all maintenance and repair service will be done by RESCO;
- The user shall pay the energy charge per unit consumption

20.14.3.2 CAPEX Model

In this type of model all the capital and operational expenses shall be borne by the user.

20.14.4 Solar Energy

Solar energy is the best form of sustainable energy. Solar electricity or photo voltaic (PV) technology converts sunlight directly into electricity.

It is proposed to provide solar panel extensively in the premises of the entire corridor wherever unused terrain especially roof tops and other locations.

It is proposed to have the following provisions for the generation/ purchase of solar energy

- Provision of fixing Solar panels on the roof top of the buildings (roof top of all station building, depot building, Traction substation, Viaduct etc)
- Provision of Ground mounted solar system, where free land is available for a longer period and along the corridor.

Figure below shows the mounting arrangements of solar panels in roof top and Ground

Rooftop Solar System

Ground-mounted Solar System

Figure 20-15: Mounting arrangements of solar panels in roof top and Ground

The table below shows the tentative plant capacity of Stations, Depot, Traction substation, viaduct and free land available in Depot.

Table 20-1 Tentative plant capacity of Stations, Depot, Traction substation, viaduct and free land available in Depot.

Table 20-1: Tentative Plant Capacity

Sr No	Location	Tentative Plant Capacity (in MWp)
1	Station Building and other service building	15
2	Depot Building and other depot area	5
3	Viaduct, compound wall fencing and track side	80
	Total	**100 MWp**

It can be increased in future by suitably locating more locations.

In addition, solar and wind energy will be brought from inter-state and intra state models.

Consent of KSEBL: KSEBL, which supplies electricity over entire Kerala has already agreed to provide green energy to this project vide their letter KSEB/TRAC/CG/Miscellaneous/2019-20/292 Dated 14th August 2019. Hence the additional requirement over and above the K- Rail's in house generation and purchase, the green energy from KSEB will be availed.

20.14.5 Green Communication and Green Networking

Green Communication and Green Networking means energy efficient communication and energy saving by avoiding travel by using communication.

Green communications are the practice of selecting energy-efficient communications and networking technologies and products and minimizing resource use whenever possible in all branches of communications.

Green networking practices include:

- Implementing virtualization.
- Practicing server consolidation.
- Upgrading older equipment for newer, more energy-efficient products.
- Employing systems management to increase efficiency.
- Substituting telecommuting, remote administration and videoconferencing for travel.

Limited usage of Fossil fuel: The communication installations and tower will be normally powered from solar or Electricity board with back up UPS and Diesel Generators (DG). Only during all out-break downs, the diesel generators will be used.

20.15 RECYCLING

Recycling is a key tool for the sustainability transport. The methods for recycling is to be strictly adhered during construction, operation and maintenance.

20.15.1 Water Recycling and Conservation

Water recycling shall be implemented in all infrastructure as far as possible. Stations and Depots will be main area where water will be used much during construction as well as operation and maintenance. Water recycling facilities in Stations and Depots will improve the recycling of the water. The recycled water can be used for gardening and toilet purposes.

20.15.2 Waste Recycling

Waste management process and machinery is indeed a part of the SilverLine project. The maintenance of Rolling Stock and other equipment will create waste products which are to be treated and disposed properly. Treatment plants are proposed in all Depots for the treatment of the maintenance wastes. Similarly, human waste from the trains are to be removed, treated and disposed properly. Controlled emission plants are used in depot to collect the toilet wastes from the trains and associated treatment plants will treat the waste for proper disposal. In all stations also waste management process are to be implemented. The collected waste from stations are to be treated and disposed either in central facility or local facilities.

20.15.3 Rainwater Harvesting

Rainwater harvesting is a technique of collection and storage of rainwater into natural reservoirs or tanks, or the infiltration of surface water into subsurface aquifers (before it is lost as surface runoff). One method of rainwater harvesting is rooftop harvesting. With rooftop harvesting, most any surface — tiles, metal sheets, plastics, but not grass or palm leaf — can be used to intercept the flow of rainwater and provide a household with high-quality drinking water and year-round storage. Other uses include water for gardens, livestock, and irrigation, etc. The rainwater harvesting will be provided on stations and depots and other offices.

20.15.4 Vermicomposting

Providing vermicomposting pit at satellite offices, to manage the quantum to biodegradable waste on surrounding. Vermicomposting facilities will be provided at all satellite offices to treat the kitchen waste as an initiative towards management of Biodegradable waste at site and generate compost for in-house landscaping.

20.16 BIO TOILETS IN TRAINS

Bio-toilets are provided in the trains as a measure of environment protection and cleanliness in the corridor, stations and yards.

20.17 ENERGY CONSERVATION MEASURES

20.17.1 Rolling Stock

The procurement specifications are to be drafted in such a way that it will implement the recycling of the materials used in Rolling Stock manufacturing and prevent the usage of hazardous material during manufacture as well as operation. Similarly, it is important to maintain the Rolling Stock with minimal impact to environment and climate. There are many measures proposed for making the Rolling stock for sustainable transport.

Light weight car body by using Aluminium based material will reduce the energy consumption considerably. Energy efficient VVVF Drives for Traction and Auxiliary converters are proposed. Extensive use of regenerative braking during the service braking is technically proven. It is used at speed as low as 5 KMPH. With modern controls, power factor is maintained almost to unity. Lights shall be of latest technology such as LED for energy efficient operation. The light level shall be controlled based on the ambient light level. Windows shall be provided to increase the use of natural lighting. Optimized control of the temperature inside the train shall be provided to reduce the energy consumption in the Air conditioning units. The air conditioning system shall monitor the passenger load and ambient conditions. Similarly, the car body and windows shall be designed to reduce the heat transmission. In the propulsion system high efficiency transformer and IGBT based inverters shall be used. The aerodynamic design shall ensure less resistance which can reduce the traction energy consumption. Energy efficient train running shall be implemented during the project execution with the advisory

system. All auxiliary machines are load controlled and VVVF driven to the extent possible. Optimized and modulated compressor operation is done using advanced software. Flange lubricators are to be used to reduce the wheel rail resistances.

20.17.2 Electrical & Mechanical Facilities

Energy charges of any High-Speed Rail system constitute a substantial portion of its operation and maintenance (O&M) costs. Therefore, it is imperative to incorporate energy saving measures in the system design itself. The traction power consumption increases with an increase in train frequency /composition in order to cater more traffic. The proposed system of High-speed Rail includes the following energy-saving features.

- Using Star rated, energy efficient equipment: In case of electrical equipment motors, pumps, air conditioners and other rotating equipment, the operating cost constitute 95 to 98 percent and the capital cost is only two to five percent of the total life cycle cost of this equipment. Hence the energy efficient and star rated equipment only is recommended to be used even if the capital cost is marginally higher.
- Natural lighting and ventilation: Effective utilization of natural light and ventilation is proposed. In addition, the lighting system of the stations will be provided with different circuits (20%,50%&100%) and the relevant circuit can be switched on as per the requirements
- Energy efficient Lights and fans: Only energy efficient lights LED technology and energy efficient fans are proposed.
- Lifts: Machine room less type lifts with gearless drive has been proposed with 3 phase VVVF drive. These lifts are highly energy efficient. Recently regenerative types of lift are under trial and these types of lift may be used to recover energy.
- Escalators: The proposed heavy-duty public service escalator will be provided with 3 phase VVVF drive, which is energy efficient and improves the power factor. Further, the escalators will be provided with infrared sensors to automatically reduce the speed (to idling speed) when not being used by the passenger.
- Air conditioners: Use of VRF/VRV type air-condition system and Thermal energy storage system will be adopted for major centralized AC system like depot, OCC and administrative buildings
- The latest state of energy efficient electrical equipment (Transformer, motors, pumps, HVAC, light fittings etc) will be incorporated into the system design
- Energy Conservation Awareness: Energy saving, and conservation concepts will be inculcated among the staff, users, passengers and other stakeholders from the beginning and periodically.

20.18 OTHER GREEN INITIATIVES

20.18.1 Usage of Electrically Operated Feeder Services

All the stations will be provided with feeder services for connecting the passengers to city centre and main locations near to the stations. Battery operated buses and rickshaws are proposed to operate in the stations.

20.18.2 Promoting Manually Driven Cycles for Local Transport

Similar to metro stations, SilverLine stations will also provide free bicycles and electrically operated scooter services to promote the clean energy transport.

20.18.3 Urban Forestry

K- Rail will be also working with agencies to implement an urban forestry program to offset greenhouse gas (GHG) emissions associated with construction. This program will deliver additional benefits such as providing shade and recreation for communities within the train corridor.

20.18.4 Landscaping

Landscaping are provided in the open spaces in the offices, depot, parking areas and along the corridors to support the environment and reduce pollution.

20.19 PAPERLESS OFFICE (PAPER CONSERVATION)

E office is a concept in which no paper is used for communications and documentations thereby preventing the cutting of precious trees and reduce GHG emissions.

The greenest paper is no paper at all, said Vince Digneo, sustainability strategist at Adobe. So by using available technology e-office concept without using is introduced from the beginning. All the documents, correspondence, communications are kept in the digital form. K- Rail has already started using E-office.

The other measures include various options in its design and project implementation to improve energy performance and reduce the pollution.

1) Harnessing of solar energy being fruitfully implemented in staff quarters, station & substation buildings for street and site security lightening, water heating and pumping.
2) Low Sulphur High Speed Diesel to run DG sets

20.20 CONCLUSION

It is ensured that all the components of sustainable development and transport project are to be incorporated in the design, construction and operation of the project in addition to the proposed usage of 100% renewable energy. This corridor will become a par-excellent model for sustainable transport.

So, the bottom line for the semi-high-speed rail line (SilverLine) is to implement a **SUSTAINABLE TRANSPORT SYSTEM**. This can be visible starting in 2025, during the system's first year of operation, K- Rail anticipates a ramp - up in usage as travellers begin to make the switch from driving or flying to take high speed rail. Every subsequent year, as the system is projected to increase riders, it is expected continued reductions in GHG emissions as well as criteria air pollutants..

Cumulatively by 2028, the semi high-speed rail system will reduce 1.1 million tons of carbon dioxide equivalent (mmtCO2e) and by 2050, the system will reduce minimum 10 million tons of CO2e.

Hence, in addition to above, incorporated with other sustainability features like less land use, no forest land, no major ecological disturbance, less pollution during construction and operation phase, the proposed semi high speed rail is a game changing form of sustainable transportation, first of its kind in India and may also be few in the world.

DETAILED PROJECT REPORT

SEMI HIGH SPEED RAIL CORRIDOR
THIRUVANANTHAPURAM TO KASARAGOD

VOLUME II - MAIN REPORT
(PART D)

CHAPTER 21
CONCLUSION & RECOMMENDATION

21 CONCLUSION & RECOMMENDATION WITH SALIENT FEATURES

21.1 GENERAL

In order to alleviate the woes of the passengers travelling between Thiruvananthapuram and Kasaragod, the Government of Kerala has planned for construction of a Semi High Speed Railway Line (named Silverline) between Thiruvananthapuram and Kasaragod and the mandate of conducting the technical study has been entrusted to Kerala Rail Development Corporation Limited (KRDCL), a Joint Venture Company between Government of Kerala and Ministry of Railways, popularly known as K-Rail. K- Rail has in turn engaged the services of M/s SYSTRA, a leading consulting and engineering firm, to prepare a Feasibility Report followed by Detailed Project Report for this project.

SilverLine is going to be a game-changer in Kerala's growth of infrastructure and economic development, is conceived to be implemented with minimum possible land acquisition and by entirely adhering to green protocol in every aspect. Not only that the project has been conceived completely in an eco-friendly manner but also has ecological improvement within its scope such as rejuvenating the abandoned paddy fields. It also has many more green features such as the use of clean energy due to large scale utilisation of solar power, reuse of concrete and steel, use of low-emission construction equipment and promoting urban forestry program. It will see that e-vehicles (preferably self-driven) are deployed for the last mile connectivity. More significantly, it will sharply reduce greenhouse gas emission mostly by cars and heavy trucks as it will substantially take away transport. The most advantageous social aspect of the project is that it will drastically reduce road accidents and save precious lives perished on the motorways.

K-Rail submitted the Feasibility Report of the proposed Silverline, prepared by M/s SYSTRA, to Government of Kerala. Government of Kerala approved the same and submitted to Ministry of Railways. In turn Railway Board has accorded In-Principle Approval (IPA) vide letter no. 2019/JV Cell/KRDCL/SHRC dated 17th December 2019, for taking up pre-investment activities for this project.

K- Rail initiated the necessary processes to collect & collate the site data through Traffic survey, LiDAR survey, Geotechnical Investigation, Environmental & Social Impact Assessment studies and conducted the necessary studies through M/s SYSTRA and this Detailed Project Report has been prepared accordingly.

21.2 SALIENT FINDINGS OF DETAILED PROJECT REPORT

For the SilverLine, after confirming the real need for a semi high speed rail corridor between Thiruvananthapuram and Kasaragod, system parameters were selected after due consideration of present high speed and semi high speed rail scenario across the world. It includes the availability of technology and resources and considering the present speed status in Indian Railway where running gauge is Broad Gauge and maximum speed is 160 kmph only. System parameters such as Standard gauge(1435mm),

Operating speed of 200 kmph, and a dedicated greenfield alignment between Thiruvananthapuram and Tirur and a dedicated alignment parallel to existing railway alignment between Tirur and Kasaragod were found to be the most appropriate for the project.

Following are the salient findings of this Detailed Project Report (DPR) prepared for the Semi High-Speed Rail Line (SilverLine) from Thiruvananthapuram to Kasaragod;

(i) The SilverLine is expected to reduce journey time from Thiruvananthapuram to Kasaragod from 12 to 14 hours by road and rail to 4 hours. The journey time may be further reduced when faster tilting trains are introduced in future.

(ii) The line will reduce pollution and improve safety on the roads by reduction in motor vehicle congestion. SilverLine will also help to increase foreign exchange reserves country by reducing dependence on fossil fuel.

(iii) For meeting the long-term transport needs of the state, construction of a separate semi high speed rail corridor is expected to be more practical, as it requires comparatively less land acquisition and construction cost, than a six-lane segregated expressway.

(iv) The SilverLine is expected to boost tourism in the state by providing speedy & comfortable daytime travel across the state which has many tourist spots like beaches, backwaters, and places of historical interest & religious importance.

(v) Planned urban development of the cities along the corridor, and development of new cities along the Silverline can facilitate the socio-economic development of the regions served by the line. Planned urban development can be in the form of vertical development in the central part of the city and in other parts by providing shorter time & seamless access to the SilverLine stations. The indirect socio-economic benefit is that people can move from the smaller towns and cities to big cities/towns on daily basis & it does not required to migrate permanently for work. This will drive the development of smaller town also.

(vi) **Traffic -** A number of traffic & transportation surveys as detailed in chapter 4 were conducted as a part of the study to assess the passenger movement pattern and travel characteristics within the study area. The data collection activities included both primary and secondary data sources such as classified traffic volume counts, origin-destination surveys, and stated preference surveys to understand the willingness to shift and pay for SilverLine. In addition, significant data from secondary sources pertaining to demographic, socio-economic characteristics, public transport system etc. was also collected as a part of the data collection activity.

For future traffic estimations, base year is considered as 2019-20, commissioning year as 2025-26 and Horizon year as 2052-53. The traffic projection covers up to 50 year (2072-73) period. The daily ridership was estimated for four different scenarios such as Pessimistic, Business As Usual, Realistic and Optimistic build based on variations in parameters such as additional infrastructure developments, additional traffic generated, growth rates based on all India GDP and difference in mode-wise probability of shift from potential trips. The daily ridership was observed to be varying between approx. ~54,000 daily trips in worst scenario to ~1,14,000 trips in optimistic scenario in 2025-26.

The realistic scenario is expected to generate approx. ~79,934 daily trips in 2025-26 (including trips from airports, feeder service and TOD development). The sectional loads were observed to be highest between Thiruvananthapuram to Kozhikode.

Apart from the above, surveys for the feasibility of operating tourist trains, sleeper trains and introducing exclusive restaurant/dining car in the SilverLine express trains were also conducted and observed that there is potential for operating tourist trains, on lease model and also for sleeper trains. It was observed that Sleeper train would be required only on weekends (3 days) and not on daily basis. Introduction of an exclusive restaurant car in trains was found to be unviable from revenue generation perspective based on the analysis.

(vii) **Alignment -** Due diligence has been taken to adopt the optimum alignment along coastal area or through mid-highlands as per requirements of the project to serve the populated areas. Accordingly the route along Mid highlands has been considered more suitable. The alignment at few locations have been close to the sea but at a distance of 200 m for 600 m length due to site constraints. The alignment from Kasaragod to Tirur (210 Km) is found more suitable along the existing railway lines and from Tirur to Thiruvananthapuram (320 Km) with deviations through green fields. The proposed alignment has been finalized based on following technical grounds;

- Sectional speed @200 Kmph to be achieved over maximum length of corridor.
- Least disturbance to existing structures/railway stations.
- Minimum requirement of re-structuring of existing ROBs/RUBs.
- To pass through lesser congested stretches.
- To pass through lesser costly land areas such as unused crop field areas over maximum stretch out of total length.
- Lesser number of buildings/structures shall be affected.
- Construction shall be easy and safer.

Section wise alignment is briefly described as under;

- **Thiruvananthapuram-Kollam:** The alignment starts from Thiruvananthapuram (Kochuveli) station and will be running parallel to existing Railway line till the existing Murukkumpuzha railway station, then takes a diversion towards right (east) and passes through green fields and reaches Kollam Station near Kollam NH-47 bypass at about 7.0 kilometres away from the existing Kollam Railway Station.
- **Kollam-Chengannur:** The alignment further passes through green fields and reaches Chengannur Station near MC road at a distance of about 4.30 km from the existing Railway Station. On the way it crosses existing Kollam-Madurai Highway and Kollam-Punalur railway line and NH-183A.
- **Chengannur-Kottayam:** The alignment passes through green fields and reaches Kottayam Station near MC road at a distance of about 4.85 km from the existing Railway Station.
- **Kottayam-Ernakulam:** The alignment passes through green fields and reaches Ernakulam Station near Info park at Kakkanad at a distance of about 10 km from the existing South Railway Station. Enroute it crosses NH-220 & NH-49. It also crosses Ernakulam to BPCL railway siding wherein RFO is proposed.
- **Ernakulam-Thrissur:** The alignment passes through green fields and reaches existing railway line and will be running parallel till near existing Angamali Railway Station to integrate with Kochi Airport. Thereafter it crosses the existing railway track and will be taking a diversion towards left side (west) and passes through green fields and reaches Thrissur to integrate with Thrissur railway station on the left of the existing Railway Station at a distance of 500 m from the centre line of the existing station to SilverLine station on southern side.
- **Thrissur-Tirur:** The alignment runs parallel and crosses Guruvayur line and takes a diversion to left side (west) to Tirur through green fields and reaches existing railway line and will be running parallel for some distance reaching Tirur.
- **Tirur-Kozhikode:** The alignment runs parallel to existing railway line on LHS observing the SilverLine parameters and reaching Kozhikode Railway station adjacent to parallel to the existing line through a cut & cover and deep tunnel starting before the Kallayi river.
- **Kozhikode-Kannur:** The alignment runs parallel and adjacent to the existing track duly observing Semi-High Speed Rail parameters and crosses the existing track and will be further running parallel to existing track up to Kannur station at a distance of 1.40 Km from the existing Kannur station on the Kasaragod side.
- **Kannur-Kasaragod:** The alignment traverses parallel & adjacent to the existing Southern Railway track up to chainage 521.815 and crosses the track as cut & cover tunnel. Thereafter the alignment continues up to the end chainage 529.45 to reach station and further beyond up to the depot.

- Coastal alignment via Alappuzha, Kochi was also studied but not found suitable as it was not serving the majority of needy population and was required to cross too many big waterbodies and CRZ areas.

(viii) **Stations -** Alignment and stations are proposed in such a manner that it passes through the city centre or as close to it so that the city population can easily reach the stations located within a short distance. There are 11 proposed stations on the Thiruvananthapuram - Kasaragod Semi High Speed Rail Corridor (SilverLine). Of these 11 stations, some of the stations pass through the city or existing CBDs while some are located away from the city centres.

- **Thiruvananthapuram**: This station is proposed on the right-hand side (eastern side) of existing Kochuveli Station and parallel to the existing second railway terminal for integration and connectivity with Southern Railway station. An extension for 4.35 Km as single line/track with “one train only system” to connect the international airport and to have an aggregate station inside the airport is proposed in future for integration with Thiruvananthapuram Airport.
- **Kollam:** This Station is proposed at a distance of 7.0 Km away from existing Southern Railway Kollam Station almost parallel to the recently opened bypass for want of suitable location at city centre. One Depot with workshop is proposed at this station as there is sufficient private land available for acquisition. The place now proposed is a fast-developing area with possible access from NH to approach the station.
- **Chengannur and Kottayam:** These stations are now proposed at distances of 4.50 Km and 4.850 Km respectively from existing railway stations for want of places near city centres. These stations are proposed near to the MC road an important State Highway in the state.
- **Ernakulam (Kochi):** This station is now proposed at a distance of 7.8Km from existing Ernakulam South Railway station for want of places near city centres and existing Railway Stations. However, this station is proposed near the Info park and proposed Smart City offices. There is a proposal to extend the existing Metro line to this area and the proposed Metro Station is nearby. The Collectorate also is nearby.
- **Thrissur:** This station is located adjacent to existing Southern Railway Thrissur station at western side to facilitate transhipment for passengers beyond Palakkad towards Bangalore, Chennai, Hyderabad etc. The station and approach tracks will be on elevated structures. Both SilverLine & Southern Railway stations will be interconnected through escalator/travellator/Lift/FOB.
- **Tirur:** This station is located at 3.5 kms towards North of existing Southern Railway station. Station will be at grade. This station will cater the requirement of Malappuram district and nearby towns. This station will also

function as transhipment station for passengers from North side towards Chennai etc.

- **Kozhikode:** This station is located adjacent to existing Southern Railway Kozhikode station at western side. This station will be an underground station and approach tracks of the station from either side will be through tunnel to reduce cost of acquisition of land through the thickly populated city area.
- **Kannur:** This station is proposed adjacent to existing Southern Railway station at eastern side. However, the proposed site is within Corporation, very fast developing area with lot of access to it. This station is planned to be provided with RORO facility station at 1.377 kms towards northern side.
- **Kasaragod:** This station is proposed on the left-hand side of existing Railway Station parallel to the existing station for integration with existing Railway Station. One Depot is proposed at this station where there is sufficient private land available for acquisition at a comparatively lesser cost.
- **Kochi Airport Railway station:** The Cochin International airport will have easy connectivity to SilverLine Railway station proposed adjacent to it on western side. This station is planned in between existing Southern Railway track and Airport. CIAL will provide feeder services from proposed SilverLine Railway station to airport.

The Cochin international airport (CIAL) and Trivandrum Airport handles approximately 27,000 and 10,000 daily international and domestic passengers respectively. In view of this, traffic and transportation surveys were conducted at these airports and after analysis, it is expected to generate 5918 daily trips from CIAL to SilverLine station. The above trips are including passengers and visitors accompanying passengers. Hence a feeder station at Nedumbassery (17km from Ernakulam SilverLine station) is proposed as part of the project. Feeder station at Trivandrum Airport will be decided in future as per requirement.

(ix)Rolling Stock & Depot - EMU (Electric Multiple Unit) trains, with driving cabs on both end of the train, are recommended for using in Thiruvananthapuram-Kasaragod Semi High Rail Corridor (SilverLine) because of the inherent advantages like better operating parameters and travel time, faster acceleration and deceleration, better adhesion, reduced axle load, more suited for regenerative braking, higher Energy Efficiency etc. Based on the traffic demand forecasted, it is proposed to begin the initial commercial services with train set of 9 (nine) car configuration, which consists of six motor cars and three trailer cars. Train configuration may be increased up to 12/15 cars from the year 2028 onwards to meet the PHPDT demand by augmentation in multiples of additional motor cars and trailer cars. Approximate Passenger capacity of around 675 for 9-car train

length has been considered. Space will be earmarked for service area, pantry, luggage, toilets etc. in each car, thereby reduction in paid area per car. Also, with multiple classes of travel being offered in the train services, the total passenger capacity gets limited because of 2+2 seat and 3+2 seat configuration. After various deliberations, it is proposed to provide maintenance Depots at Kollam and Kasaragod for the SilverLine corridor. The Depot at Kollam will have full-fledged facilities to maintain and refurbish the Rolling Stock. The Depot at Kasaragod will have minimum maintenance facilities for inspection and stabling the Rolling Stock. The Depot will be equipped with various infrastructures such as stabling lines, inspection bay lines, workshop bay lines, wheel lathe plant etc. and machinery and plants such as pit jacks, bogie maintaining equipment etc.

(x) **Power Supply & Traction -** It is planned to use 100 percent of power from renewable sources for the operation of SilverLine. The proposed traction feeding system for SilverLine operation is AC, 50Hz, 2x25 kV Autotransformer (AT) type. 8 Traction substations and 13 auxiliary substations are proposed for train operation and auxiliary services. Scott connected type transformers are recommended at traction substation. It is recommended to have the simple catenary system for SilverLine operation up to the speed of 250 kmph. It is proposed to have SCADA and Building Management System (BMS) at Operation Control Centre (OCC) to monitor and control the traction and auxiliary supply.

(xi) **Signalling, Communication and Ticketing & Fare Collection System** – The LTE-R (Long Term Evolution-Railway) standard supports high speeds and capacity for wireless data transmission networks and offers the ability to consolidate delivery of multi-service traffic into a single wireless network. Well known for its roll-out on commercial mobile networks, LTE is rapidly being adapted for the railway industry for ground-to-train voice and data communications. Operators using LTE will be able to integrate the transfer of safety-critical signalling, closed-circuit television, passenger information system as well as onboard internet services into one network. In addition, operating rail control solutions with LTE-R will enable enhanced system stability and data encryption and security.

ETCS level-2 digital radio-based signal & train protection is recommended for the SilverLine project. The movement authority is communicated directly from a Radio Block Centre (RBC) to the on-board unit using a radio channel (LTE). Occupancy of the track sections are detected by axle centres. The proposed signalling system is designed to have a headway of 3 minutes. ATS (Automatic Train Supervision) totally manages and controls train operation, scheduling etc. OCC (Operational Control Centre) which support safe and sustainable train operation will be the brain of Silverline trains.

Semi High-Speed Railway Transportation system is expected to handle a large volume of passengers. The ticketing system shall be computerized system for effective management of the process of reservation, ticket issuing and inspection with a view to improve convenience of users. The system shall handle all functionalities of the ticketing process, management, access control, fare management, payment, financial requirements, settlement between different registered operators. The system shall generate a financial report and management reports. The system is responsible for internal and external interface with all ticketing process through gateway and third party. The system software and hardware shall ensure, secured transaction, processing of ticket and payment using appropriate high-level security technology. The system shall ensure the ability to obtain complete and clear data backup and recovery of operation process. A central computer system shall be in redundant configuration and located at OCC and BCC (Backup Control Centre).

(xii) **Operation & Maintenance –** The SilverLine passenger services will operate on this double line section primarily. Freight services (RORO) will share the same route with the passenger services to the extent planned operation permit. The entire corridor is provided with horizontal curve of radius of 1850m or more except at some station approaches and with vertical curve of 17500m radius. Hence an operational speed of 200 kmph is achievable in all sections of the corridor. All stations are provided with loop lines for SilverLine trains and RORO trains for managing the operational flexibility. In 2025 around 39 trips of train operation in one direction is planned and 6 trips of RORO operation in one direction is planned. The RORO will be operated during off peak hours and night hours. The OCC and BCC will cooperate and ensure the proper time scheduling of trains and manage the operation loops in the corridor as per the traffic demand. The trains are stabled either in Depot or Mainline as per the operational flexibility.

(xiii) **Project Cost/Economic & Financial –** The total cost of SilverLine project is Rs 63,940.67 Crore including land cost, IDC and taxes. The project FIRR works out to be 8.49% with the concession period of 50 years. The Equity IRR works out as 13.55% with the concession period of 50 years and the Economic IRR works out to 24.04%.

(xiv) **Project Implementation Plan–** The construction and commissioning of the SilverLine can be done in one go for the entire route of 529.45 Kms from Thiruvananthapuram to Kasaragod, if the funds are available for the full project. The entire length of project can be implemented and commissioned over a period of five years from 2020-21 to 2025-26 (including approval, etc). Based on the "in-principle" approval received from Ministry of Railways, the land acquisition process

can start since the funding for the same to be borne by Government of Kerala. Physical work can start after the project is approved by Government of India and financial closure is established.

If the project is taken up in parts, i.e. funds are available in stages, the whole project covering a length of 529.45 kms can be implemented and commissioned in a phased manner with first phase between Thiruvananthapuram and Thrissur (Phase I-260 Km) and the second phase from Thrissur to Kasaragod (Phase II-270 Km). It is estimated that phase-I will take 4-4.5 years (including approval), and the entire project in 6- 6.5 years (including approval). In Phase I, the construction activities can be taken up commencing from Ernakulam (Kakkanad) towards Kochuveli (196 km) and towards Thrissur (64 km) - total of approximately 260 km, so that the coaches & RS can be maintained at Kollam depot. In Phase II, Thrissur to Kasaragod for 270 km can be taken up.

Implementation and commissioning of entire project in one go is recommended as it will benefit the whole state at the earliest.

(xv) **TOD/Property Development -** It is suggested to develop the station premises by the operating agency itself by joining with state government undertakings or private developers since the area in front of the station has huge commercial potential. Also it is advised to consider the use of new land by the creation of new destinations for the public such as university, amusement park, medical centre, IT parks, tourist attractions and residential township around the SilverLine stations, especially in suburban area such as Thiruvananthapuram (Kochuveli), Kollam, Kottayam, Ernakulam, Thrissur. These destinations can stimulate passengers and increase the traffic volume which may bring a positive economic effect to the areas around the station. These kinds of new development should be considered by local bodies and government and reflected in the regional development plans.

TOD may be undertaken by a separate SPV formed for this purpose. Land and other infrastructure cost for TOD are not forming part of the project.

(xvi) **Project Financing Option –** After elaborate study, it is recommended that funding pattern for the SilverLine shall be in the form of tied loan from JICA along with public equity as detailed in Table 21-1 & Table 21-2.

Table 21-1: Proposed Financing Model

Source	Amount (Rs. in Crore)	% Contribution	% Share of total Project Cost
MOR/GOI - Equity Cash	2150	4.85%	4.89%
MOR/GOI - Equity Land	975	2.20%	
GOK Equity	3252.56	7.34%	5.09%
Public Equity Participation	4,251.71	9.59%	6.65%
Loan from bilateral/multilateral agencies	33,699.80	76.02%	52.70%
Total Cost Excluding Land, R&R & Taxes	**44,329.07**	**100%**	
MOR/GOI SD for Central taxes (100%)	3,188.73		4.99%
GOK SD for Land and R&R (100%)	11,837.25		18.51%
GOK SD for Land on JDA (Deferred Payment Scheme)	1,525.08		2.38%
GOK SD for State Taxes (100%)	2,896.46		4.53%
Total Completion Cost before IDC	**63,776.59**		
IDC to be borne by GOK	**164.08**		0.26%
Total Completion Cost including IDC	**63,940.67**		100.00%

Table 21-2: Contribution against completion cost

Capital Outlay	(INR Crores)	% Share
Ministry of Railway - Govt of India	6313.13	9.87%
Govt of Kerala	18,150.35	28.39%
Govt of Kerala (deferred payment)	1,525.08	2.39%
Public Equity Participation	4,251.71	6.65%
Bilateral Loan	33,699.80	52.70%
Total	**63,940.67**	**100%**

(xvii) Recommendation – The study clearly reveals that the State of Kerala needs a modern, efficient, faster, safer, affordable, sustainable and eco-friendly means of transport across the state between Thiruvananthapuram and Kasaragod to meet its growing transport requirements and a Semi High speed rail Corridor (SilverLine) is the best option for the same. The 529.45 route-kms SilverLine is a double line standard gauge Railway connecting Thiruvananthapuram to Kasaragod with an operating speed of 200KMPH. It eases the transport between North & South ends of the state and reduces the total travel time to less than 4 hours, compared with the present 10-12 hours.

The semi high-speed rail corridor (SilverLine) connecting the 11 districts & 10 cities of Kerala longitudinally will act as a growth engine for the socio- economic development of the entire state. It will enhance the social cohesion among residents as it connects the entire state and promotes a sense of togetherness, by bringing distant populated areas close together. From the planning point of view, it will facilitate new growth of multi zonal, multi nuclear urban structure in and around, to reduce and re-distribute the pressure from the existing urban spaces. From the resilient point of view, the corridor will open avenues to connect "high and dry" areas that are safe and have the potential to increase socio-economic opportunities of the State. Integrating the multimodal transportation along the corridor will create ripple of growth and facilitate better connectivity with the surrounding. From a connectivity point of view, a high-speed rail corridor will connect the airports, health facilities, institutions, cultural amenities, and commercial nodes.

Along with the social benefits, the corridor will also stimulate long term economic benefits - encourage commercial and industrial growth in, around and along the corridor. This will create new employment opportunity and also widen employment base. Besides connecting the entire State, it will also reduce the travel time, improve energy consumption, encouraging high density, mixed-use, and real estate development along the corridor and around the transit nodes. It will also foster economic development in tier-II & III towns along the corridor and also create new growth centres. The corridor will also expand tourism opportunities. Overall, the high-speed rail corridor will integrate the districts that can function as a single stronger economy.

Based on this elaborate technical study and economic analysis of this SilverLine corridor from Thiruvananthapuram to Kasaragod, it is recommended to construct the Semi High Speed Rail Corridor (SilverLine) of 529.45 Km length as a green corridor using renewable energy to have higher mobility, meet the traffic growth, enhance the environment and socio-economic development of the State.

In order to expedite the project and to get suggestions to make the project more fruitful, a series of meetings/discussions/presentations happened with concerned

Railways & GOK authorities. In this regard, meetings were held with Southern Railway, High Powered Committee of Government of Kerala chaired by the Hon CM, Chief Secretary, Chamber of Commerce, etc. Detailed deliberations to make the project more feasible & viable, took place during these meetings and all the relevant suggestions have been incorporated in this Detailed Project Report.

21.3 WAY FORWARD

- Submission of the Draft DPR to K-Rail Board for approval.
- Submission of DPR to Govt of Kerala for approval.
- State Government may freeze all the developments along the corridor suggested, to avoid further construction within 30m from the centre line of the proposed alignment.
- Submission of the DPR to Southern Railway Headquarters for comments and suggestions.
- Forwarding of DPR to Ministry of Railways.
- Approval of DPR by Ministry of Railways.
- Approval by NITI Aayog.
- Approval by the extended Railway Board.
- Approval by Cabinet Committee on Economic Affairs (CCEA).
- Cabinet approval for project execution.

21.4 PROJECT AT A GLANCE

Name of the Project	:	Semi High Speed Rail Project from Thiruvananthapuram to Kasaragod (Named as SilverLine).
Executing Company	:	SPV of Kerala Rail Development Corporation Limited (K-Rail)
Project Length	:	529.45 kms
Gauge	:	Standard Gauge of 1435 mm
Operational Speed	:	200 kmph
Travel Time	:	4 hrs (approx.)
Construction Period	:	2020-25 (Five Years)
FIRR	:	5.84% over 30 years and 8.49% over 50 years
EIRR	:	24.04% over 50 years
Type of Train	:	EMU type train set-9 cars Extendable to 12/15 cars
Seating	:	2+2 (Business), 3+2 (Standard) 675 Passengers in 9 cars train

Ridership	:	79,934 in 2025-26
Power Supply	:	From KSEBL through solar & other renewable energy.
Signal & Comm.	:	ETCS Level 2 with LTE
Stations	:	11 including Kochi Airport
Project Cost on Completion	:	Rs 63,940.67 Crores

21.5 SALIENT FEATURES

(1) Structure of Route Length:

Total Length	**529.45 Kms.** (Centre line to Centre line of Stations)
Structure	
a) Viaduct	88.41 Kms
b) Tunnel	11.52 Kms
c) Cutting	101.73 kms
d) Bank	292.72 Kms
e) Cut & Cover	24.78 Kms
f) Bridges	12.99 Kms
Total Route Length	**532.185 Kms.** (End to End of the route length)

(2) Station names with chainage and inter distance:

Sl.No.	Name of station	Chainage (KM)	Inter-station distance (KM)	Elevated / At grade
1	Thiruvananthapuram	0	1100	Elevated
2	Kollam	55358	55358	At grade
3	Chengannur	102900	47543	At grade
4	Kottayam	136108	33208	At grade
5	Ernakulam	195308	59200	Elevated
6	Kochi Airport Station	212305	16998	At grade
7	Thrissur	259118	46813	Elevated
8	Tirur	320565	61447	At grade
9	Kozhikode	357827	37262	At grade

Sl.No.	Name of station	Chainage (KM)	Inter-station distance (KM)	Elevated / At grade
10	Kannur	446095	89273	Underground
11	Kasaragod	529450	83515	At grade

(3) Traffic Forecast: Thiruvananthapuram - Kasaragod: Ridership over different horizon years.

Estimated Ridership Forecast for Different Horizon Years for Thiruvananthapuram – Kasaragod

Parameters	2025-26	2029-30	2041-42	2052-53
Ridership	79,934	94,672	1,32,944	1,58,946
Passenger. km	58,35,182	69,11,056	97,04,912	1,16,03,058
Average Trip Length (km)	200	200	200	200

(4) Civil Engineering:

4.1 Underground Structures	NATM method of construction. Cross Sectional Area 80 m².
4.2 Super structure for bridges, Viaducts etc.	Either box Girder or double 'U' type girder. Generally, 30m in length.
4.3 Viaduct	Supported on single columns generally
4.4 Bank Top width	12 m
4.5 Cutting bottom width	12m

4.6 Track Structure	• Mostly ballasted Track for main line except over viaducts & Tunnels where ballastless track is used. • Ballasted Track in Depot except washing line and inspection bays.
4.7 Min horizontal Curve Radius	1,850 m
4.8 Min Vertical Curve Radius	17,500m
4.9 Max Cant	160mm
4.10 Permissible Cant Deficiency (desirable)	100mm
4.11 Permissible Cant Deficiency (maximum)	100mm
4.12 Max Gradient	1 in 60
4.13 Distance between Track Centres	4.5 m
4.14 Car Width	3.4 m
4.15 Max. Axle Load of car	16-17 Ton (UIC Loading Standards)
4.16 Width of Track Formation	12 m
4.17 Tunnel Cross Section (Standard Double Track)	80 m^2

(5) Speed:

a) Operating Speed : 200 KMPH

b) Maximum Design Speed : 220 KMPH (structures designed for 250 kmph)

(6) Train Operation: The train operation plan has been taken for headway of 15, 15,10 and 10 minutes in the year 2025-26, 2029-30, 2040-41 & 2052-53 respectively during the peak period.

(7) Traction Power Supply:

a) Traction feeding system: 2X25 KV Auto Transformer Type feeding System

b) Current Collection: Over Head Contact System (CCS)

c) Power Requirements:

Year	2025-26	2032-33	2042-43	2052-53
Power demand (MVA)	104	119	158	184
Energy consumptio (million units)	279	321	427	497

(8) **Rolling Stock:** To start with, 9 car Train with the capacity of 9 car is 675 passengers. This train length can be increased to 12/15 cars in future with capacity of 900/1125 passengers respectively.

8.1 Train Composition

Type of Train: EMU with 9 cars extended as 12/15 cars

Train Carrying Capacity: For 9 cars, 675 passengers

8.2 Train Length (in meter) incl. auto coupler

: 9 car train – 225 m (approx.)

:15 car train – 375 m (approx.)

8.3 Length of Coach : 25.00 m (average)

8.4 Width of Coach : 3.4 m(maximum)

8.5 Height of Coach : 4.5 m

8.6 Axle Load (T) : Maximum Axle load is taken 16 - 17 Ton for Passenger Train, design proposed as per UIC load.

8.7 Coach

Coach construction : Lightweight equipment and coach body aluminium body

8.8 Propulsion

Traction circuit & configuration: 3 phase drive system with VVVF Inverter control using IGBT and asynchronous traction motor / PMSM

Braking system: Electric Regenerative brake with continuous blending of Electro Pneumatic friction brakes and parking brakes.

(9) Train Control: Continuous automatic train protection with continuous transmission of permanent movement authority (ETCS Level 2 System based on LTE Radio Communication with Train).

(10) Signalling & Communication: ETCS Level -2 (European Train Control System) with LTE. LTE Communication System without loss at speeds up to 350 kmph. Cab Signalling on board system.

Automatic train control system with ATP, ATO (equivalent to GOA level2) with block length of approximately 8 km. Operation Control Centre (OCC) with Backup Control Centre (BCC) with RBC capable of handling 50 trains (approx.). Mobile Radio System, CCTV Telephone, PAS, PIDS, Clock etc.

(11) Fare Collection: Central Computer System (CCS), Smart Card (EMV based), Mobile Apps/ Mobile web Application, Station Computer System (SCS), Ticket Office Machine (TOM), Ticket Vending Machine (TVM)/ Self, Service Ticketing KIOSKS, Mobile Ticket Counter (MTC), Portable Processing unit (PPU), Automatic Gate (AG)

(12) Total Estimated Cost Without Taxes (at March 2020 Prices):

Rs. 49918.70 Crores (inclusive of land).

(13) Total Estimated Cost with all taxes & duties (March 2020 base):

Rs. 55053.83 Crores (inclusive of cost of land).

(14) Estimated completion cost with all taxes, land cost, Escalation & IDC:

Rs 63940.67 Crores (inclusive of cost of land).

(15) Proposed Fare: Rs. 2.75 per km in Standard Class.

KERALA RAIL DEVELOPMENT CORPORATION LTD.
5th Floor, Trans Towers, Vazhuthacaud, Thycaud P.O.
Thiruvananthapuram, Kerala - 695 014
Phone: 0471-2324330, 2326330 Fax: 0471 2325330
krdclgok@gmail.com | www.keralarail.com, www.krdcl.co.in

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94468 79687